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JULY 1993

SYSTEM ASSURANCE ANALYSIS
OF THE
175-TON BRIDGE CRANE

AT THE
VEHICLE ASSEMBLY BUILDING

Baseline Number: 389.00

PMN: K60-0528

WUC: TAFCRVD000

SS/FC: TA

SYSTEM: CRITICAL

National Aeronautics and
Space Administration
John F. Kennedy Space Center



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APPLICATION		PART NO.	MF	REVISIONS			
NEXT ASSY	USED ON			SYM	DESCRIPTION	DATE	APPROVAL
				A	REVISED AND REDRAWN PER NSTS 22206, REV. B.	8/89	TFM
				B	COMPLETE REVISION AND UPDATE TO NSTS 22206, REV. C. INCORPORATED EO1 & EO2. REMOVED 15 CRIT 1 CRITICAL ITEMS (FMN .017, .020, .021, .024, .026, .027, .028). REMOVED 15 CRIT 2 CRITICAL ITEMS (FMN .048, .051, .052, .055, .057, .058, .059). REMOVED 1 CRIT 2 FLEXHOSE. REASSESSED 11 CRITICAL ITEMS FROM CRIT 1 TO CRIT 2. ADDED 28 CRIT 2 CRITICAL ITEMS (12 FROM EO2, 16 NEW).	7/30/93	MKG

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UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES	ORIGINAL DATE OF DRAWING 12/78 DRAFTSMAN TRACER ENGINEER BANBURY SUBMITTED F. BANBURY APPROVED C.Q. STEWART	SYSTEM ASSURANCE ANALYSIS OF THE 175-TON BRIDGE CRANE AT THE VEHICLE ASSEMBLY BUILDING CMD BASELINE NO. 389.00 SCALE UNIT WT	JOHN F. KENNEDY SPACE CENTER, NASA KENNEDY SPACE CENTER FLORIDA DWG SIZE SAA09FY12-006 A SHEET 1 OF 520
MATERIAL			
HEAT TREATMENT			
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1.0 SUMMARY OF FINDINGS AND RECOMMENDATIONS

1.1 CRITICALITY ASSESSMENT SUMMARY

The 175-Ton Bridge Crane at the VAB is assessed as critical because failure to support a load or loss of control of the load could cause loss of life/vehicle and/or damage to a vehicle system. See section 4.0 on page 22 for additional information.

1.2 MECHANICAL FMEA SUMMARY

There was 1 mechanical Critical Item identified in the critical functions assessed in section 4.0 for this system. It is summarized below. See section 5.1 on page 26 and section 6.0 on page 323 for additional information.

Table 1. **Mechanical Critical Items**

<u>Ref Des/ Find No.</u>	<u>Nomenclature</u>	<u>Critical Failure Mode</u>	<u>Criticality Category</u>
79K16830-8 (M16)	Cable Reel Assembly	Fail to Provide Torque	2
		Brake Fails to Engage	2

1.3 ELECTRICAL FMEA SUMMARY

There were 60 electrical Critical Items identified in the critical functions assessed in section 4.0 for this system. They are summarized below. See section 5.2 on page 46 and section 6.0 on page 323 for additional information.

Table 2 (Page 1 of 4). **Electrical Critical Items**

<u>Ref Des/ Find No.</u>	<u>Nomenclature</u>	<u>Critical Failure Mode</u>	<u>Criticality Category</u>
<u>Main Hoist</u>			
M12-G4	Motor- Generator Set	No Output	1
M13	Motor, Drive	Open Armature Winding	1
M14	Motor, Drive	Open Armature Winding	1
1MC	Switch, Master Control	N.O. Contact Fails Closed	2
1HCR	Relay	N.O. Contact Fails Open	2
		N.O. Contact Fails Closed	2
1LCR	Relay	N.O. Contact Fails Open	2
		N.O. Contact Fails Closed	2

Table 2 (Page 2 of 4). **Electrical Critical Items**

<u>Ref Des/ Find No.</u>	<u>Nomenclature</u>	<u>Critical Failure Mode</u>	<u>Criticality Category</u>
1HS	Relay	N.C. Contact Fails Open	2
HCR RUN	Relay	Coil Fails Open	2
		N.O. Contact Fails Open	2
		N.C. Contact Fails Closed	2
LCR RUN	Relay	Coil Fails Open	2
		N.O. Contact Fails Open	2
		N.C. Contact Fails Closed	2
1XR	Relay	N.O. Contact Fails Closed	2
1FW	Relay	Coil Fails Open	2
		N.O. Contact Fails Open (1 of 3)	2
S2	Switch, Foot	N.O. Contact Fails Open	2
		N.O. Contact Fails Closed	2
		N.C. Contact Fails Closed	2
1RUN	Relay	"PULL IN" Coil Fails Open	2
		N.O. Contact Fails Open/	2
		N.C. Contact Fails Closed	
RPOT	Potentiometer	Fails Open	2
1RR4A	Resistor	Fails open	2
1RR4B	Resistor	Fails open	2
FPOT	Potentiometer	Fails Open	2
1RR7	Resistor	Fails open	2
M1	Meter Relay	High/Low limit No. 2	2
		N.C. Contact Fails Open	
K10	Relay	Coil Fails Open	2
		N.O. Contact Fails Open	2
1VR	Relay	N.O. Contact Fails Closed	2
1KR	Relay	N.O. Contact Fails Open	2
1SRX	Relay	Coil Fails Open	2
		N.O. Contact Fails Open	2
1FC	Generator Field DC Input Controller	No output	2
		High Output (Not Inverted)	2
		High Output (Inverted)	2
1XR1	Relay	Coil Fails Open	2
		N.O. Contact Fails Open (1 of 3)	2

Table 2 (Page 3 of 4). **Electrical Critical Items**

Ref Des/ Find No.	Nomenclature	Critical Failure Mode	Criticality Category
1SYNT/1SYNR1	Synchro Transmitter and Receiver Assembly (Selsyn)	Erroneous Output	2
<u>Auxiliary Hoist</u>			
M9-G3	Motor- Generator Set	No Output	2
M10	Motor, Drive	Open Armature Winding	2
M11	Motor, Drive	Open Armature Winding	2
2MC	Switch, Master Control	N.O. Contact Fails Closed	2
2HCR	Relay	N.O. Contact Fails Open N.O. Contact Fails Closed	2 2
2LCR	Relay	N.O. Contact Fails Open N.O. Contact Fails Closed	2 2
2HS	Relay	N.C. Contact Fails Open	2
HCR RUN	Relay	Coil Fails Open N.O. Contact Fails Open N.C. Contact Fails Closed	2 2 2
LCR RUN	Relay	Coil Fails Open N.O. Contact Fails Open N.C. Contact Fails Closed	2 2 2
2XR	Relay	N.O. Contact Fails Closed	2
2FW	Relay	Coil Fails Open N.O. Contact Fails Open (1 of 3)	2 2
S2	Switch, Foot	N.O. Contact Fails Open N.O. Contact Fails Closed N.C. Contact Fails Closed	2 2 2
2RUN	Relay	"PULL IN" Coil Fails Open N.O. Contact Fails Open/ N.C. Contact Fails Closed	2 2
RPOT	Potentiometer	Fails Open	2
2RR4A	Resistor	Fails open	2
2RR4B	Resistor	Fails open	2
FPOT	Potentiometer	Fails Open	2

Table 2 (Page 4 of 4). **Electrical Critical Items**

Ref Des/ Find No.	Nomenclature	Critical Failure Mode	Criticality Category
2RR7	Resistor	Fails open	2
M2	Meter Relay	High/Low limit No. 2 N.C. Contact Fails Open	2
K9	Relay	Coil Fails Open N.O. Contact Fails Open	2 2
2VR	Relay	N.O. Contact Fails Closed	2
2KR	Relay	N.O. Contact Fails Open	2
2SRX	Relay	Coil Fails Open N.O. Contact Fails Open	2 2
2FC	Generator Field DC Input Controller	No output High Output (Not Inverted) High Output (Inverted)	2 2 2
2XR1	Relay	Coil Fails Open N.O. Contact Fails Open (1 of 3)	2 2
2SYNT/2SYNR2	Synchro Transmitter and Receiver Assembly (Selsyn)	Erroneous Output	2
<u>Bridge</u>			
RPOT	Potentiometer	Fails Open	2
3FC	Generator Field DC Input Controller	High Output (Not Inverted) High Output (Inverted)	2 2
3SYNT/3SYNR	Synchro Transmitter and Receiver Assembly (Selsyn)	Erroneous Output	2
<u>Trolley</u>			
RPOT	Potentiometer	Fails Open	2
4FC	Generator Field DC Input Controller	High Output (Not Inverted) High Output (Inverted)	2 2
4SYNT/4SYNR	Synchro Transmitter and Receiver Assembly (Selsyn)	Erroneous Output	2
<u>Field and Brake Circuit</u>			
12CB	Circuit Breaker	Contact Fails Open (1 of 3)	2
4TR3	Transformer	Winding Fails Open or Shorted	2

1.4 FLEXHOSE FMEA SUMMARY

There are no flexhoses associated with the critical functions assessed in section 4.0 for this system.

1.5 ORIFICE FMEA SUMMARY

There are no orifices associated with this system.

1.6 FILTER FMEA SUMMARY

There are no filters associated with the critical functions assessed in section 4.0 for this system.

1.7 HAZARD ANALYSIS SUMMARY

A list of applicable hazard reports has been developed from a search of the KSC/RT Hazard Database for existing, baselined hazards. Copies of all applicable hazard reports are contained in Section 7.3. There were one controlled and two accepted risk hazards identified during this analysis. These are summarized below.

Table 3. **Hazards Identified**

<u>Identification</u>	<u>Description</u>	<u>Classification</u>
RT-ENG-1027	Flight hardware damage/loss and/or personnel injury/death due to VAB 250/175 Ton Crane or lifting device failure.	Accepted Risk
RT-ENG-1019	Personnel working under suspended load for SRB processing (RPSF/VAB), Orbiter stacking (VAB), SSME maintenance (VAB/Pad), and MDD (SLF/CLS/KSC).	Accepted Risk
V-FAC-GEN-HR-08	Loss of personnel/flight hardware during lifting operations.	Controlled

1.8 LPS CONTROL/MONITOR FUNCTIONS REVIEW SUMMARY

There are no LPS control/monitor functions associated with this system.

1.9 SNEAK CIRCUIT ANALYSIS SUMMARY

There was no Sneak Circuit Analysis performed on this system.

1.10 RECOMMENDATIONS

The risk associated with the Critical Items identified in section 6.0 on page 324 should be accepted by management based upon the acceptance rationale provided on the associated Critical Items List Sheets.

1.11 AREAS OF CONCERN SUMMARY

There were no Areas of Concern identified with this system.

1.12 CRITICALITY CATEGORY 1R ITEMS SUMMARY

There were 4 criticality category 1R items identified in the critical functions assessed in section 4.0 for this system. See section 13.0 on page 518 for additional information.

2.0 SYSTEM BASELINE/GROUND RULES/DEFINITIONS/DOCUMENTATION

2.1 SYSTEM BASELINE

This system is baselined for STS by 79K09579, "KSC Facilities, Systems, and Equipment Organizational Level OMD Baseline," dated 1/7/93. The OMD Baseline Number is 389.00.

2.2 GROUND RULES

This analysis has been developed in accordance with NSTS 22206, Rev. C, "Requirements for Preparation and Approval of Failure Modes and Effects Analysis (FMEA) and Critical Items List (CIL)."

The following additional ground rules and assumptions were used during this analysis.

- a. Voltage selector switches (VSS), voltmeters 1VM, 2VM, & 7VM and ammeter 6AM (2AM for bridge and trolley circuits) were not analyzed in the FMEA since these items are not used during crane operations.
- b. Switch, 3KS, was not analyzed in the FMEA since this switch is used for skew correction of the bridge and is not used during crane operation.
- c. The relay assembly, consisting of relays K1-K8, light PL1, switch S1 and fuse F1, was not analyzed in the FMEA since this is used to test the continuity of various indication circuits in the system and is not used during crane operation.
- d. The power supplied to, and distributed from, the circuit lighting panel, except the supply to the operators console radios, was not analyzed in the FMEA since this is not directly involved with operation of the crane.
- e. During the previous revision of this analysis, the failure mode of "Relay Coil Fails Open" for the Instantaneous Overload Relays 1-OLA, 2-OLA, 3-OLA, & 4-OLA was determined to be not credible because of the large physical size of the coil. This rationale will be maintained in this revision.
- f. Failure of the speed selector switches (SS2 & SS3) to change speed ranges when commanded will be assessed as criticality category 3. If the switch failed closed and remained in coarse speed, the failure can be detected prior to entering a critical situ-

ation because per OMI Q3008, Operating Instructions, the crane is required to be operated in the fine speed mode when a critical load is within 10 ft. of any structure. This allows for adequate time and distance to stop if the hoist, bridge or trolley remain in coarse speed.

If the switch failed closed and remained in high speed, the failure can be detected prior to entering a critical situation because the hoist would be operated in the coarse mode while connecting the GSE to the hook and a failure would be detected at this time. The hoist is never placed in high speed mode while there is a load on the hook.

- g. The current configuration of the crane contains only one upper limit switch. This is in violation of NSS/GO-1740.9B. ESR K13962 (PCN95695) has been submitted to correct this discrepancy.
- h. During all operations there is at least one Emergency Stop (E-Stop) operator positioned in full view of the load block, lifting fixtures, and fixture attachment points. When the load is being moved, there must be complete control over all motions or the operation will be stopped.
- i. Failures which reduce current to and weaken the DC motor field in the bridge and trolley drives will be assessed as criticality category 3. This failure could result in a speed increase of the affected drive system when there is no load on the hook. However, with a load on the hook a speed increase will not be experienced because of the reduced torque capability of the motors, which also results from the weakened field.

2.3 DEFINITIONS OF CRITICALITY AND HAZARD CATEGORIES

The following criticality and hazard categories were used throughout this analysis.

2.3.1 Criticality Definitions and Categories. Criticality definitions and categories are defined as follows:

<u>Category</u>	<u>Definitions</u>
1	Single failure which could result in loss of life or vehicle.
1R	Two hardware items, which if failed, could result in loss of life or vehicle.
1S	Single failure in a safety or hazard monitoring system that could cause the system to fail to detect, combat, or operate when needed during the existence of a hazardous condition and could result in loss of life or vehicle.
2	Single failure that could result in loss (damage) of a vehicle system.
3	All others.

Cause - Major reason or event that produces a failure mode.

Component - A combination of parts, devices, and structures, usually self contained, which perform a distinctive function in the operation of the overall equipment. A "black box" (e.g., transmitter, power supply, cryogenic pump, filter assembly).

Correcting Action - An identification of actions, automatic or manual, which could be taken to mitigate the effect of failure.

Critical System - Ground Support Equipment/Facility Systems (GSE) is assessed as critical if loss of overall system function or improper performance of a system function could result in the loss of life, loss of vehicle, or loss (damage) of a vehicle system.

Critical Item - A critical item is defined as a Criticality Category 1, 1S, or 2 Single Failure Point or a redundant hardware item where the second failure results in loss of life or vehicle and the item is not capable of checkout prior to use.

Criticality Assessment - An analysis of each system function to determine if loss or improper performance of the function could result in loss of life, vehicle, and/or loss (damage) of a vehicle system without regard to redundancy.

Fail Safe - The ability to sustain a failure without causing loss of life/vehicle or damage to a vehicle system. (Includes the capability to safe the systems and successfully terminate operations).

Failure - The inability of a system, subsystem, component, or part to perform its required function within specified limits, under specified conditions for a specified duration.

Failure Mode - A description of the manner in which an item can fail.

Function - The activity or operation that a part, component, or system must perform to accomplish its intended purpose.

Interface - The point or area where a relationship exists between two or more parts, systems, programs, persons, or procedures wherein physical and/or functional compatibility is required.

Like Redundancy - Identical hardware items performing the same function.

Redundancy Screens - The following screens will be evaluated for all identified criticality category 1R items.

Screen A - The redundant item is capable of being checked and verified prior to use.

Screen B - Loss of the redundant item is readily detectable by the ground crew. (This screen is not applicable to standby redundancy.)

Screen C - Loss of all redundant items cannot result from a single credible cause, such as contamination.

Line Replaceable Unit (LRU) - An item whose replacement constitutes the optimum organizational maintenance repair action for a higher indenture item, i.e., any assembly which can be removed and replaced as a unit from the system at the operating location.

Loss (Damage) of Vehicle System - Loss of the capability to provide the level of system performance required for normal or emergency operations.

Operational Redundancy - Redundant elements, all of which are fully energized during the subsystem operating cycle. Operational redundancy includes load sharing redundancy wherein redundant elements are connected in such a manner that, upon failure of one unit, the remaining redundant elements will continue to perform the subsystem function. Switching out the failed element is not required.

Passive Component - A component that may be necessary to the performance or structural integrity of the system but has no active function.

Prerequisite Control Logic - GSE software program logic that assures proper sequence of commands.

Reactive Control Logic - GSE software program logic that assures automatic reaction to indicated failures.

Safety or Hazard Monitoring System - A system whose function is to detect, combat, or operate when needed during a hazardous condition which has occurred because of prior failures or events.

Standby Redundancy - Redundant hardware items that are nonoperative until they are switched into the subsystem upon failure of the primary items. Switching can be accomplished by either automatic or manual means.

Unlike Redundancy - Non-identical items performing the same function.

2.3.2 Hazard Definitions and Categories. Hazard definitions and categories are defined as follows:

Hazard - The presence of a potential risk situation caused by an unsafe act or condition.

Hazard Analysis - The determination of potential sources of danger and recommended resolutions in a timely manner for those conditions found in either the hardware/software systems, the person-machine relationship, or both, which cause loss of personnel capability, loss of system, or loss of life or injury to the public.

Hazard Report Closure Classification.

- a. **Eliminated Hazard** - A hazard that has been eliminated by removing the hazard source or by deleting the hazardous operations.
- b. **Controlled Hazard** - The likelihood of occurrence has been reduced to an acceptable level by implementing the appropriate hazard reduction precedence sequence to comply with program requirements.
- c. **Accepted Risk** - Hazard which has not been counteracted by redundancy purge provisions, appropriate safety factors, containment/isolation provision, backup system/operation, safety devices, alarm/caution and warning devices, or special automatic/manual procedures. Catastrophic hazards, critical hazards, hazards resulting from failure to meet program requirements, and Single Failure Points (SFPs) in emergency systems will be documented. A hazard will be classified as an "accepted risk" only after (1) all reasonable risk avoidance measures have been identified, studied, and documented; (2) project/program management has made a decision to accept the risk on

the basis of documented risk acceptance rationale; and (3) Safety management has concurred in the accepted risk rationale.

Severity Level - Should the hazard occur, its worst case severity would be:

- a. Catastrophic - Hazard could result in a mishap causing fatal injury to personnel, and/or loss of one or more major elements of the flight vehicle or ground facility.
- b. Critical - Hazard could result in serious injury to personnel, and/or damage to flight or ground equipment which would cause mission abort or a significant program delay (one or more days).
- c. Marginal - Hazard could result in a mishap of minor nature inflicting first-aid injury to personnel, and/or damage to flight or ground equipment which can be tolerated without abort or repaired without significant program delay (less than one day).

Hazard Report Status.

- a. Closed - Corrective action to eliminate or control the hazard is completed, evaluated, and verified and management actions to accept the safety risks are completed. Actions taken, organization which performed actions and completion dates are to be documented in this data element.
- b. Open - Corrective action evaluation and verification is in progress. The status shall remain open until management has reviewed the actions taken and accepted the safety risk. Actions required, organization responsible for performing the actions and due dates are to be documented in this data element.

2.4 DOCUMENTATION LIST

The following documents were used in completing this analysis:

Table 4 (Page 1 of 3). **System Documentation List**

<u>Document/Drawing No.</u>	<u>Rev.</u>	<u>Outstanding EO Numbers</u>	<u>Title</u>
General Electric	July 1965	None	LC39, VAB, 175-Ton Bridge Crane (FMEA)
GP 1098F	Basic	None	KSC Ground Operation Safety Plan
NSS/GO-1740.9B	November 1991	None	NASA Safety Standard for Lifting Devices and Equipment
NSTS 22206	C	None	Instructions for Preparation of Failure Modes and Effects Analysis (FMEA) and Critical Items List (CIL)
NSTS 22254	Basic	None	Methodology for Conduct of NSTS Hazard Analyses

Table 4 (Page 2 of 3). **System Documentation List**

<u>Document/Drawing No.</u>	<u>Rev.</u>	<u>Outstanding EO Numbers</u>	<u>Title</u>
OMI Q3008	F	None	Operating Instructions for the 175-Ton and 250-Ton Bridge Cranes, VAB
OMI Q6003	D	None	Maintenance Instructions for the 175-Ton and 250-Ton Bridge Cranes, VAB
SAA09ELR2-001	A	None	System Assurance Analysis of the 60 Hz Facility Power in the VAB
SAA09FT07-006	B	None	System Assurance Analysis of the ET Forward and Aft Erection Slings at the VAB
SAA09CU07-009	Basic	None	System Assurance Analysis of the RF Communications System at the VAB Cranes
SAR H70-0597	Basic	None	Safety Analysis Report of the Orbiter Mating Sling Set
389.00	June 1992	None	VAB Cranes File VI OMRSD
TM4-151-39 Volumes 1 and 2	Basic	None	Technical Manual Apollo/Saturn Launch Complex 39 Operating Instruction/Maintenance Manual 175-Ton Bridge Crane
29 CFR 1910	Basic	None	Occupational Safety & Health Administration, Labor Regulations
67-K-L-11348	R	9	Vehicle Assembly Building 175-Ton Bridge Crane Electrical
79K04421	Basic	None	Field Loss Relay Modifications 175-Ton and 250-Ton Cranes 1 and 2
79K05056	Basic	1	Modifications of 175- and 250-Ton Bridge Crane
79K11844	A	None	System Documentation List VAB Facility Systems, Cranes
79K16497	B	1	General OMRSD for Load Sensitive Cranes/Hoists
79K16830	Basic	1	Mechanical Arrangement 175-Ton Bridge Crane, VAB

Table 4 (Page 3 of 3). **System Documentation List**

<u>Document/Drawing No.</u>	<u>Rev.</u>	<u>Outstanding EO Numbers</u>	<u>Title</u>
79K16835	Basic	1	VAB Cranes OMRSD
79K17670	Basic	None	LRU-Parts List VAB Facility Systems, Cranes

3.0 SYSTEM DESCRIPTION

The 175-Ton Bridge Crane is an electric bridge crane with a main hook load capacity of 175 tons and an auxiliary hook load capacity of 25 tons. The crane was specifically designed for assembly, subassembly and handling operations of space vehicles in the Vehicle Assembly Building (VAB) (see figures 1 and 2).

The crane operates on crane rails 169 feet above the VAB floor. The crane travels the distance of the VAB transfer aisle. It is mainly used with one of the VAB 250-Ton Bridge Cranes that run between High Bays 1 and 2 or between High Bays 3 and 4, for rotation of flight hardware. The main hoist is used for handling the Orbiter and External Tank. The auxiliary hoist is used for handling the SRB forward assemblies. Each hoist has redundant mechanical drive systems. Each drive system can move or hold the load if necessary. Crane motions are controlled from the console in the operator's cab located under one bridge truss and are as follows:

- Hoisting and lowering the main and auxiliary load hooks
- Transverse movement of the trolley across the bridge (east/west)
- Traverse movement of the bridge along the craneway (north/south)
- Main hook swiveling

The main hoist, auxiliary hoist, bridge and trolley drives are configurations using motor-generator (M-G) sets that supply power to the DC drive motors. Each M-G set consists of a constant-speed AC motor driving a DC generator. Variations in power to the field of the DC generator provide correspondent variations in power to the DC drive motors.

The cab has four lever-operated master switches (joystick). Each master control switch provides on/off control of AC power to the relay circuit which in turn provides on/off control of DC power to brake solenoids and to the generator field winding of the M-G set. The master control switch also contains a potentiometer which provides variable input of DC power to a solid state generator field controller which supplies the DC power to the generator field of the M-G set. This controls the movements of the main and auxiliary hoist load blocks, and the bridge and trolley travel. Each lever has a ball end with a thumb latch on top. The thumb latch is a detent or lock for the neutral position of the lever only. Pressing down on the thumb latch releases the master switch lever from the off position. Each master switch lever has a squeeze-type lever at the side, which enables the release of the brake when required for float control. The speed of the motor controlled by the master switch is proportional to the displacement or movement of the switch lever from the neutral position. Full displacement will produce maximum motor speed in the speed range selected (excluding the float mode). There are no detents or steps. The master switches are arranged on the cab console so that the crane will move in the direction which the lever is pushed.

The crane drive systems provide for four speed drive options:

- High Speed: Used for rapid hoisting and lowering of an empty hook (Main & Aux Hoist only).
- Coarse Speed: Used for maneuvering the load over significant distances (approximately 1/3 of the High Speed range).

- Fine Speed: Used for maneuvering the load at slower speeds (approximately 1/5 of the Coarse Speed range) while in close proximity of a structure.
- Float Speed: Used for minute movements of the load at a very slow speed (approximately 1/10 of the Coarse Speed range) for final load positioning (Main & Aux Hoist only).

For precise movement of the crane, a selsyn shaft position indicator and digital counter is available for each drive system on the crane. The selsyn consists of a synchro transmitter driven by a belt from the motor, a signalling five-wire conductor system, and a synchro receiver located in the cab console. The receivers are directly connected to the selsyn motor position-indicator dials and geared to the digital counters. The sole function of the selsyn is to monitor, electrically, the position of a shaft in one location, and display it at another location. The various shaft rotations are displayed on dials on the console.

The load block for the main hoist contains a drive mechanism for rotating the hook 360°. A hydraulic system provides a means for engaging a sliding jaw chuck which in turn engages the hook swivel mechanism to allow for swiveling of the hook. The hydraulic system consists of a reversible pump, actuating cylinder and connecting hoses. The load block receives its power from the trolley through a reeled conductor cable. The cable reel motor provides torque in only the up direction. When the main hook is lowered, it pulls the cable from the reel down against the torque of the reel motor.

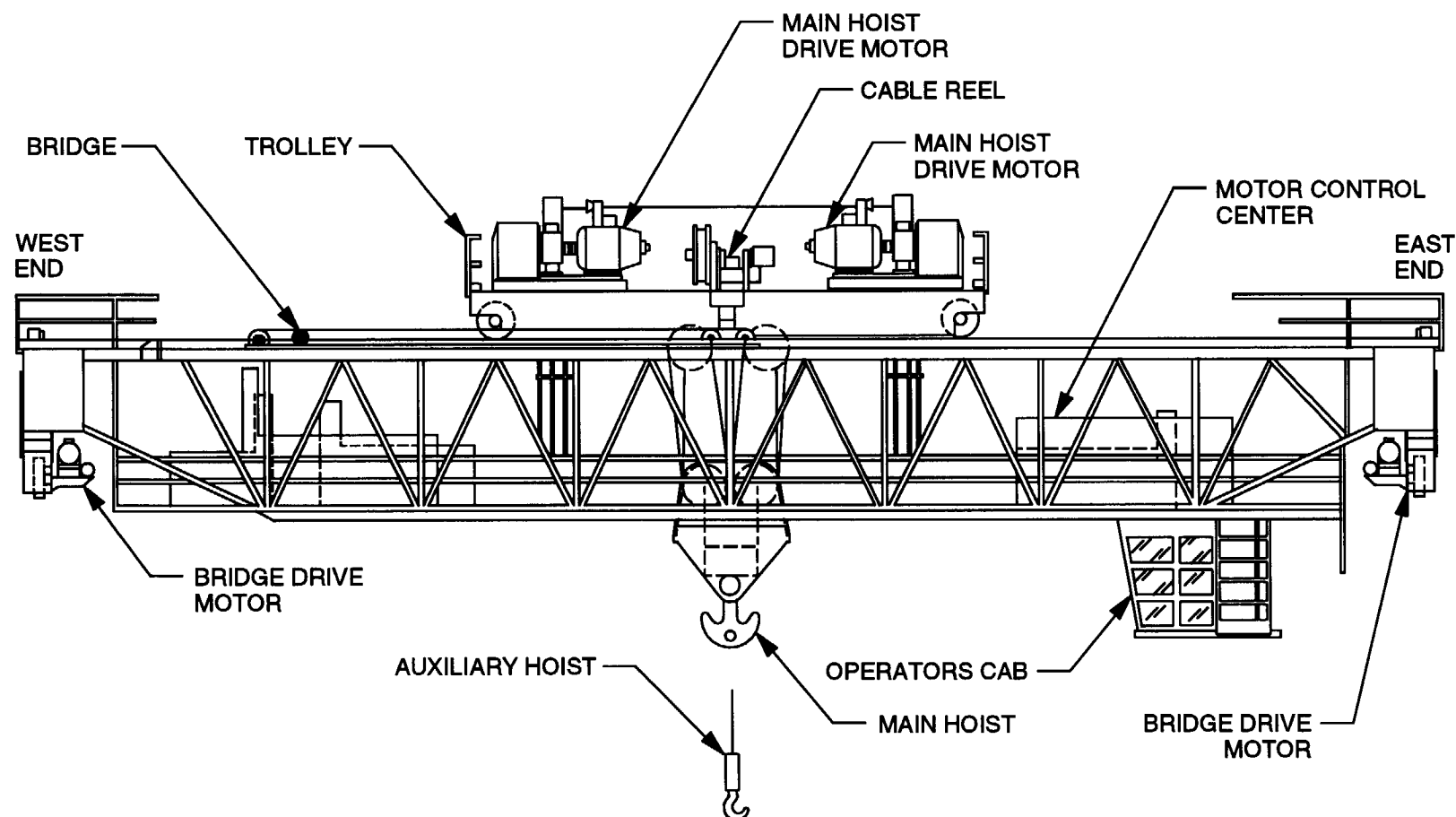


FIGURE 1. VAB 175-TON BRIDGE CRANE, ELEVATION VIEW

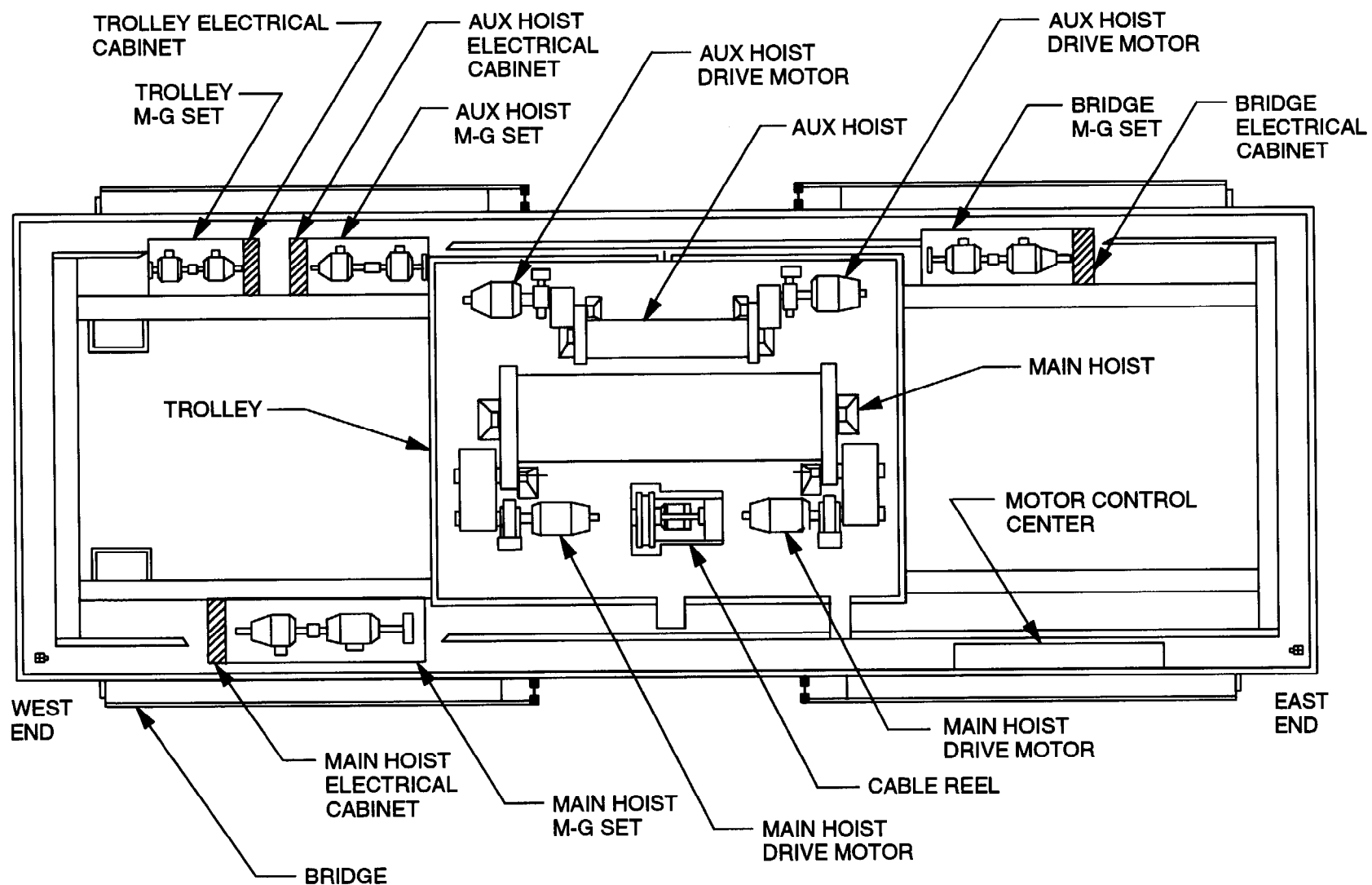


FIGURE 2. VAB 175-TON BRIDGE CRANE, PLAN VIEW

4.0 CRITICALITY ASSESSMENT

The system functions are identified in Figure 3 on page 23 and assessed on the following Criticality Assessment Sheets (Worksheet 5312-001).

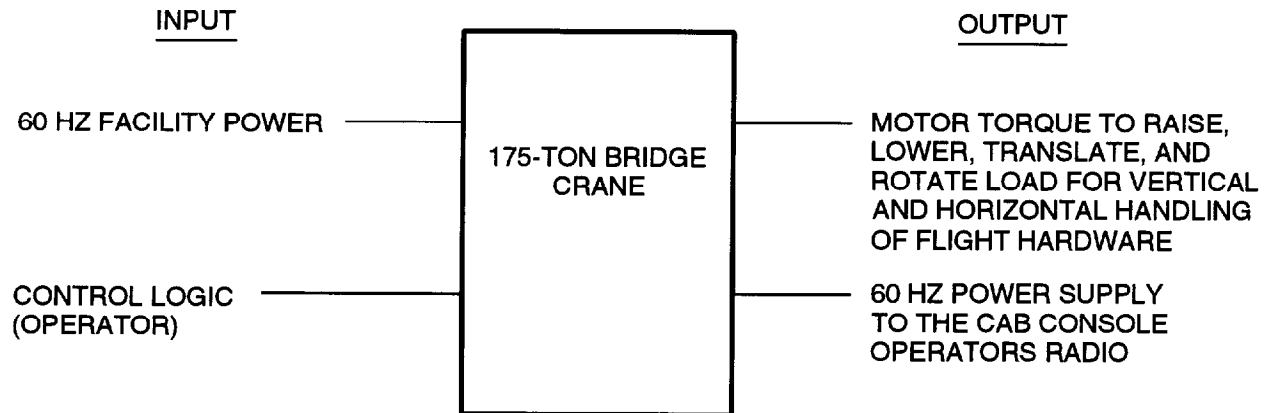


FIGURE 3. SYSTEM FUNCTIONS BLOCK DIAGRAM OF THE VAB 175-TON BRIDGE CRANE

Table 5 (Page 1 of 2). CRITICALITY ASSESSMENT - K60-0528					
Program Model Number K60-0528 Baseline Number 389.00		System/Subsystem 175-TON BRIDGE CRANE Location VAB		Station Set/Facility Code TA/VAB Date JULY 1993 Prepared By C. CRABB, LSOC 52-11	
INPUT/OUTPUT	FUNCTION	TIME PERIOD	EFFECT OF LOSS/FAILURE IF: a. FAILS TO OPERATE ON TIME b. FAILS TO CEASE OPERATION ON TIME c. FAILS DURING OPERATION d. PREMATURELY OPERATES	CRIT/ NONCRIT	NOTES
<u>INPUT</u> 60 HZ FACILITY POWER	PROVIDES POWER FOR OPERATING CRANE.	AS REQUIRED	a. CRANE CANNOT BE STARTED. DELAY IN OPERATIONS. b. NA c. CRANE WILL BE SHUT DOWN, THE BRAKES WILL SET AND ALL CRANE MOTIONS WILL STOP. DELAY IN OPERATIONS. d. NA	a. NC b. NA c. NC d. NA	TWO OPERATORS MAN CONTROLS DURING ALL CRITICAL LIFTING OPERATIONS. OPERATOR ERROR IS NOT ANALYZED IN THIS FMEA PER NSTS 22206, REV. C. SEE HAZARD ANALYSIS SECTION 7.0 FOR FURTHER INFORMATION.
CONTROL LOGIC (OPERATOR)	PROVIDES CONTROL FOR OPERATING CRANE AND HANDLING LOAD.	AS REQUIRED	a. LOSS OF CONTROL OF CRANE. b. LOSS OF CONTROL OF CRANE. c. LOSS OF CONTROL OF CRANE. d. LOSS OF CONTROL OF CRANE.	a. C b. C c. C d. C	
<u>OUTPUT</u> MOTOR TORQUE TO RAISE, LOWER, TRANSLATE, AND ROTATE LOAD FOR VERTICAL AND HORIZONTAL HANDLING OF FLIGHT HARDWARE AND GROUND SUPPORT EQUIPMENT (GSE).	175-TON MAIN HOIST: RAISE AND LOWER SHUTTLE FLIGHT ELEMENTS TO SUPPORT VEHICLE PROCESSING.	AS REQUIRED	a. LOAD WILL NOT MOVE. DELAY IN OPERATIONS. b. LOAD MAY DROP RESULTING IN A POSSIBLE LOSS OF LIFE AND/OR VEHICLE, OR DAMAGE TO A VEHICLE SYSTEM. c. LOAD MAY DROP RESULTING IN A POSSIBLE LOSS OF LIFE AND/OR VEHICLE, OR DAMAGE TO A VEHICLE SYSTEM. d. LOAD MAY DROP RESULTING IN A POSSIBLE LOSS OF LIFE AND/OR VEHICLE, OR DAMAGE TO A VEHICLE SYSTEM.	a. NC b. C c. C d. C	
	175-TON MAIN HOIST HOOK SWIVEL: ROTATE THE MAIN HOIST HOOK FOR PROPER ALIGNMENT TO MATE WITH GSE TO SUPPORT VEHICLE PROCESSING.	AS REQUIRED	a. HOOK WILL NOT MOVE. DELAY IN OPERATIONS. b. HOOK WILL CONTINUE TO ROTATE. DELAY IN OPERATIONS. c. HOOK MAY CONTINUE TO ROTATE OR STOP. DELAY IN OPERATIONS. d. HOOK MAY ROTATE PREMATURELY. DELAY IN OPERATIONS.	a. NC b. NC c. NC d. NC	

Table 5 (Page 2 of 2). CRITICALITY ASSESSMENT - K60-0528					
Program Model Number K60-0528 Baseline Number 389.00		System/Subsystem 175-TON BRIDGE CRANE Location VAB		Station Set/Facility Code TA/VAB Date JULY 1993 Prepared By C. CRABB, LSOC 52-11	
INPUT/OUTPUT	FUNCTION	TIME PERIOD	EFFECT OF LOSS/FAILURE IF: a. FAILS TO OPERATE ON TIME b. FAILS TO CEASE OPERATION ON TIME c. FAILS DURING OPERATION d. PREMATURELY OPERATES	CRIT/ NONCRIT	NOTES
60 HZ POWER SUPPLY TO THE CAB CONSOLE OPERATORS RADIOS.	25-TON AUX. HOIST: RAISE AND LOWER SRB FORWARD ASSEMBLY TO SUPPORT VEHICLE PROCESSING.	AS REQUIRED	a. LOAD WILL NOT MOVE. DELAY IN OPERATIONS. b. LOAD MAY DROP RESULTING IN A POSSIBLE DAMAGE TO A VEHICLE SYSTEM. c. LOAD MAY DROP RESULTING IN A POSSIBLE DAMAGE TO A VEHICLE SYSTEM. d. LOAD MAY DROP RESULTING IN A POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	a. NC b. C c. C d. C	
	BRIDGE MOTION: TRANSLATES MAJOR SHUTTLE FLIGHT ELEMENTS NORTH/SOUTH TO SUPPORT VEHICLE PROCESSING.	AS REQUIRED	a. LOAD WILL NOT MOVE. DELAY IN OPERATIONS. b. LOAD MAY HIT THE VAB WALL RESULTING IN A POSSIBLE DAMAGE TO A VEHICLE SYSTEM. c. LOAD MAY HIT THE VAB WALL RESULTING IN A POSSIBLE DAMAGE TO A VEHICLE SYSTEM. d. LOAD MAY HIT THE VAB WALL RESULTING IN A POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	a. NC b. C c. C d. C	
	TROLLEY MOTION: TRANSLATES MAJOR SHUTTLE FLIGHT ELEMENTS EAST/WEST TO SUPPORT VEHICLE PROCESSING.	AS REQUIRED	a. LOAD WILL NOT MOVE. DELAY IN OPERATIONS. b. LOAD MAY HIT THE VAB WALL RESULTING IN A POSSIBLE DAMAGE TO A VEHICLE SYSTEM. c. LOAD MAY HIT THE VAB WALL RESULTING IN A POSSIBLE DAMAGE TO A VEHICLE SYSTEM. d. LOAD MAY HIT THE VAB WALL RESULTING IN A POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	a. NC b. C c. C d. C	
	SUPPLIES POWER TO OPERATE THE CAB CONSOLE OPERATORS RADIOS.	AS REQUIRED	a. DELAY IN OPERATIONS. b. DELAY IN OPERATIONS. c. LOSS OF COMMUNICATIONS BETWEEN THE CRANE OPERATOR AND THE SUPERVISOR ON THE FLOOR DURING LOAD MOVEMENT OPERATIONS. LOAD MAY HIT THE VAB WALL, FLOOR OR VEHICLE TRANSPORTER RESULTING IN A POSSIBLE DAMAGE TO A VEHICLE SYSTEM. d. DELAY IN OPERATIONS.	a. NC b. NC c. C d. NC	a. NONE b. NONE c. SEE GROUND RULE h. d. NONE

5.0 FAILURE MODES AND EFFECTS ANALYSIS (FMEA)

5.1 MECHANICAL FMEA

The mechanical components of the critical functions assessed in section 4.0 for this system were identified from the documents and diagrams referenced in Table 4 on page 15 and are depicted on the following figures and analyzed in the associated Mechanical FMEA (Worksheet 5312-003). A passive items list precedes the Mechanical FMEA and is shown in listed in the Table 6 on page 27

MECHANICAL FAILURE MODES AND EFFECTS ANALYSIS
FOR THE
VAB 175-TON BRIDGE CRANE

175-TON MAIN HOIST

PMN: K60-0528

The following components were considered passive in the analysis for this system.

Table 6. **Mechanical Passive Item List**

Hooks	Rope Drums
Trolley Rails	Load Blocks
Bridge Structure	Bridge Drive Truck Wheels
Wire Ropes	Trolley Structure
Sheaves	Trolley Drive Truck Wheels
Bridge Rails	

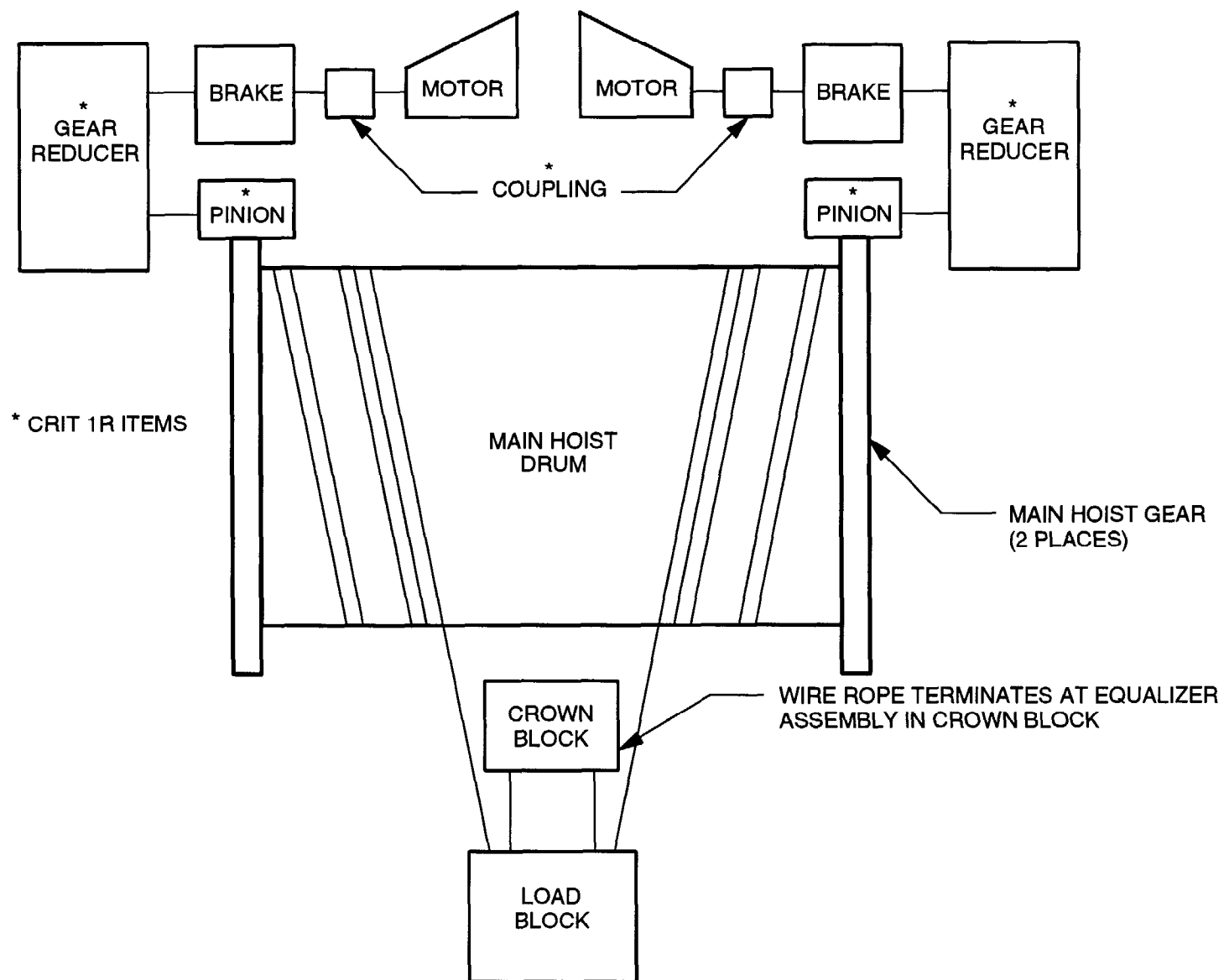


FIGURE 4. MAIN HOIST BLOCK DIAGRAM

SAA09FY12-006
REV. B

Table 7 (Page 1 of 2). MECHANICAL FMEA - 175-TON MAIN HOIST ASSY						
System 175-TON BRIDGE CRANE, VAB Subsystem 175-TON MAIN HOIST ASSY Drawing No. 79K16830 Sheet No. 2 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 4 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
79K16830/4 IMPERIAL ELECTRIC D-69.72 (M13 & M14)	DC MOTOR, MAIN HOIST (2 TOTAL)	DRIVES MAIN HOIST.	a. NO OUTPUT DUE TO MECHANICAL FAILURE (ELECTRICAL CIRCUIT REMAINS INTACT)	LOSS OF ABILITY TO CONTROL THE LOAD. REDUNDANT MOTOR CAN CONTROL THE LOAD ON ITS OWN. IF BOTH MOTORS FAILED THE BRAKES CAN BE SET TO CONTROL THE LOAD. MULTIPLE FAILURE REQUIRED TO RESULT IN DAMAGE TO A VEHICLE SYSTEM. DELAY OF OPERATIONS.	NO EFFECT.	3
79K16830/6 GE CR 9528	MAIN HOIST BRAKE (2 TOTAL)	HOLDS LOAD.	a. FAILS TO ENGAGE	LOSS OF ABILITY TO HOLD THE LOAD. REDUNDANT BRAKE CAN HOLD THE LOAD ON ITS OWN. IF BOTH BRAKES FAILED THE MOTORS CAN CONTROL THE LOAD. MULTIPLE FAILURE REQUIRED TO RESULT IN DAMAGE TO A VEHICLE SYSTEM. DELAY OF OPER- ATIONS.	NO EFFECT.	3
			a. FAILS TO DISENGAGE	UNABLE TO OPERATE HOIST. DELAY IN OPERATIONS.	NO EFFECT.	3
79K16830/3 WESTERN GEAR D605	MAIN HOIST GEAR TRAIN (1 OF 2) INCLUDES REDUCER, PINION AND DRUM	TRANSMITS POWER FROM MOTOR TO HOIST DRUM.	a. GEAR DISENGAGEMENT b. STRUCTURAL FAILURE c. 09FY12-006.091 d. CURRENT FLUCTUATION ON THE CONSOLE AMMETER e. NONE f. SECONDS g. N/A	LOSS OF ABILITY TO HOLD THE LOAD IF COUPLED WITH A FAILURE IN THE REDUNDANT DRIVE SYSTEM.	POSSIBLE LOSS OF LIFE AND/OR VEHICLE.	1R

Table 7 (Page 2 of 2). MECHANICAL FMEA - 175-TON MAIN HOIST ASSY						
System 175-TON BRIDGE CRANE, VAB Subsystem 175-TON MAIN HOIST ASSY Drawing No. 79K16830 Sheet No. 2 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 4 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
79K16830/3 WESTERN GEAR D605	MAIN HOIST GEAR TRAIN (1 OF 2) INCLUDES REDUCER, PINION AND DRUM	TRANSMITS POWER FROM MOTOR TO HOIST DRUM.	a. GEAR DISENGAGEMENT b. STRUCTURAL FAILURE c. 09FY12-006.092 d. CURRENT FLUCTUATION ON THE CONSOLE AMMETER e. NONE f. SECONDS g. N/A	LOSS OF ABILITY TO HOLD THE LOAD IF COUPLED WITH A FAILURE IN THE REDUNDANT DRIVE SYSTEM.	POSSIBLE LOSS OF LIFE AND/OR VEHICLE.	1R
79K16830/5 SHER-BATH SIZE 3-1/2	MAIN HOIST FLEX COU- PLING (1 OF 2)	COUPLES MOTOR TO GEAR REDUCER.	a. DISENGAGES b. STRUCTURAL FAILURE c. 09FY12-006.093 d. CURRENT FLUCTUATION ON THE CONSOLE AMMETER e. RETURN 1MC TO NEUTRAL OR HIT THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	LOSS OF ABILITY TO HOLD THE LOAD IF COUPLED WITH A FAILURE IN THE REDUNDANT DRIVE SYSTEM.	POSSIBLE LOSS OF LIFE AND/OR VEHICLE.	1R
79K16830/5 SHER-BATH SIZE 3-1/2	MAIN HOIST FLEX COU- PLING (1 OF 2)	COUPLES MOTOR TO GEAR REDUCER.	a. DISENGAGES b. STRUCTURAL FAILURE c. 09FY12-006.094 d. CURRENT FLUCTUATION ON THE CONSOLE AMMETER e. RETURN 1MC TO NEUTRAL OR HIT THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	LOSS OF ABILITY TO HOLD THE LOAD IF COUPLED WITH A FAILURE IN THE REDUNDANT DRIVE SYSTEM.	POSSIBLE LOSS OF LIFE AND/OR VEHICLE.	1R

MECHANICAL FAILURE MODES AND EFFECTS ANALYSIS

FOR THE

VAB 175-TON BRIDGE CRANE

MAIN HOIST LOAD BLOCK

PMN: K60-0528

The following components were considered passive in the analysis for this system.

Table 8. **Mechanical Passive Item List**

Hooks	Rope Drums
Trolley Rails	Load Blocks
Bridge Structure	Bridge Drive Truck Wheels
Wire Ropes	Trolley Structure
Sheaves	Trolley Drive Truck Wheels
Bridge Rails	

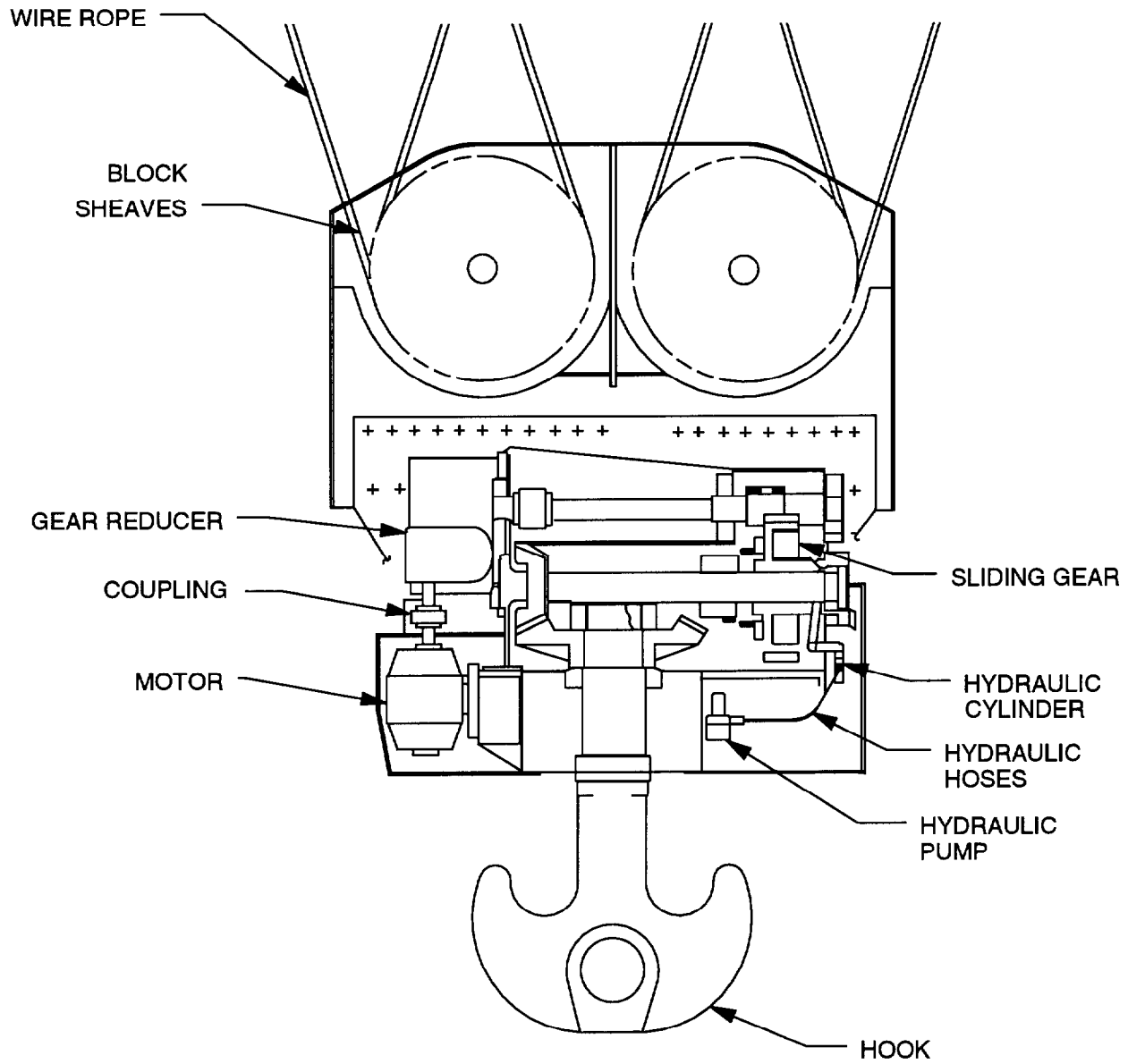


FIGURE 5. LOAD BLOCK FOR THE MAIN HOIST

Table 9. MECHANICAL FMEA - 175-TON MAIN HOIST LOAD BLOCK ASSY						
System 175-TON BRIDGE CRANE, VAB Subsystem 175-TON MAIN HOIST LOAD BLOCK ASSY Drawing No. 79K16830 Sheet No. 2 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 5 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
79K16830/15 IMPERIAL ELECTRIC 256U (M15)	MAIN HOIST HOOK SWIVEL MOTOR	DRIVES MAIN HOIST HOOK SWIVEL.	a. FAILS TO OPERATE	UNABLE TO ROTATE LOAD. DELAY IN OPERATIONS.	NO EFFECT.	3
79K16830/16 SHER-BATH OV-77350-C	MAIN HOIST HOOK SWIVEL GEAR TRAIN. INCLUDES REDUCER, CLUTCH AND BEVEL GEARS	TRANSMITS POWER FROM HOOK SWIVEL MOTOR TO HOOK.	a. GEAR DISENGAGEMENT	UNABLE TO ROTATE LOAD. DELAY IN OPERATIONS.	NO EFFECT.	3
79K16830/17 SHER-BATH SIZE 1-1/2	MAIN HOIST HOOK SWIVEL COUPLING	COUPLES HOOK SWIVEL MOTOR TO REDUCER.	a. DISENGAGES	UNABLE TO ROTATE LOAD. DELAY IN OPERATIONS.	NO EFFECT.	3
79K16830/18 SHER-BATH SIZE 3-1/2	MAIN HOIST HOOK SWIVEL COUPLING	COUPLES HOOK SWIVEL REDUCER TO HOOK SWIVEL SLIP JAW CLUTCH.	a. DISENGAGES	UNABLE TO ROTATE LOAD. DELAY IN OPERATIONS.	NO EFFECT.	3
OIL-DYNE	HYDRAULIC PUMP	PROVIDES HYDRAULIC POWER TO HOOK SWIVEL CLUTCH ACTUATION CYL- INDER.	a. FAILS TO OPERATE	UNABLE TO ENGAGE OR DISENGAGE HOOK SWIVEL CLUTCH. DELAY IN OPERATIONS.	NO EFFECT.	3
OIL-DYNE 51-0174	HYDRAULIC CYLINDER	ACTUATES HOOK SWIVEL CLUTCH MECHANISM.	a. FAILS TO OPERATE	UNABLE TO ENGAGE OR DISENGAGE HOOK SWIVEL CLUTCH. DELAY IN OPERATIONS.	NO EFFECT.	3

MECHANICAL FAILURE MODES AND EFFECTS ANALYSIS

FOR THE

VAB 175-TON BRIDGE CRANE

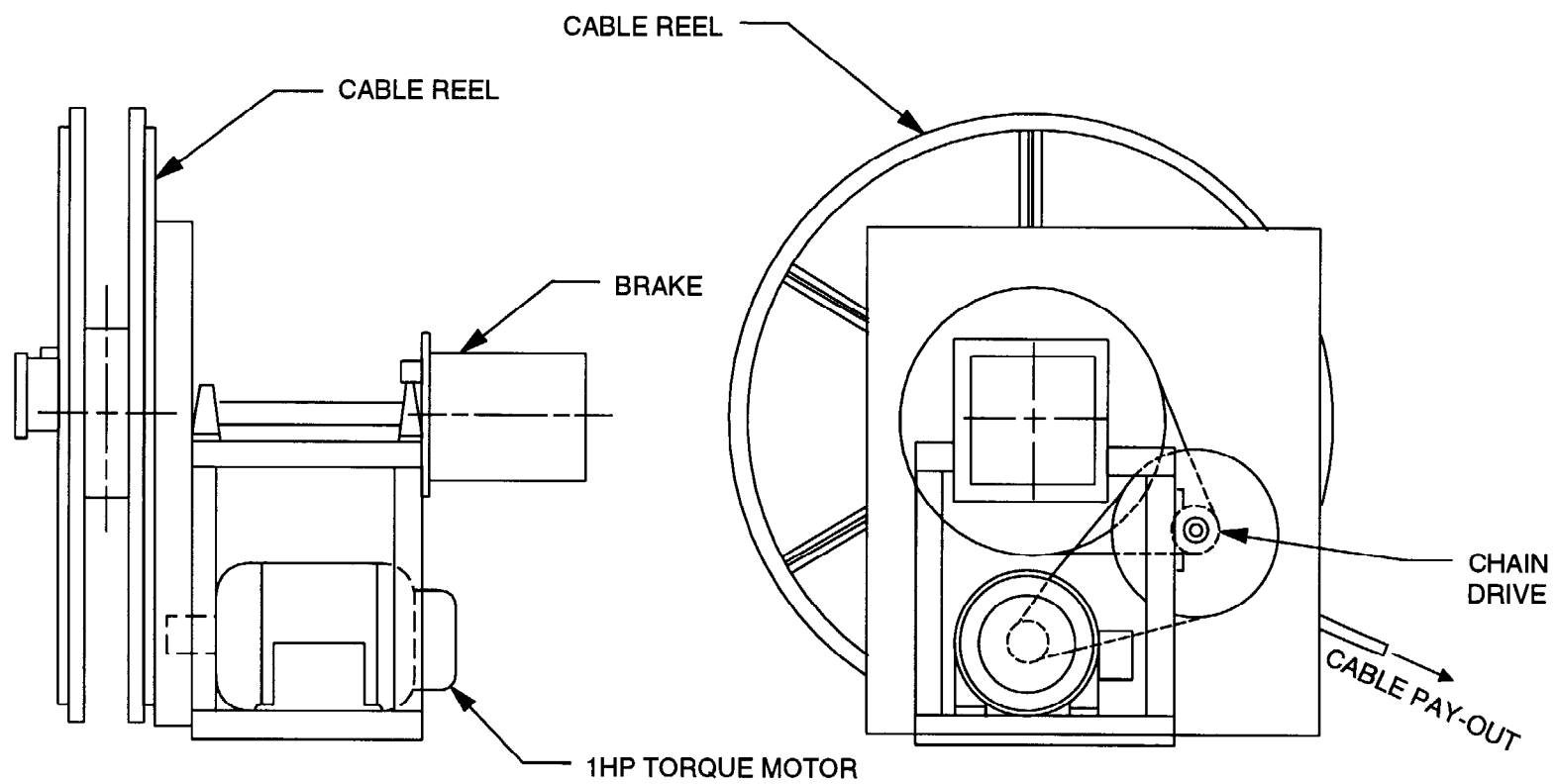
CABLE REEL ASSEMBLY

PMN: K60-0528

The following components were considered passive in the analysis for this system.

Table 10. **Mechanical Passive Item List**

Hooks	Rope Drums
Trolley Rails	Load Blocks
Bridge Structure	Bridge Drive Truck Wheels
Wire Ropes	Trolley Structure
Sheaves	Trolley Drive Truck Wheels
Bridge Rails	



(CRIT 2 ITEM)

FIGURE 6. CABLE REEL ASSEMBLY

Table 11. MECHANICAL FMEA - CABLE REEL ASSY						
System 175-TON BRIDGE CRANE, VAB Subsystem CABLE REEL ASSY Drawing No. 79K16830 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 6 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
79K16830/8 INDUSTRIAL ELECTRIC STYLE #5008 (M16)	CABLE REEL ASSEMBLY (INCLUDES MOTOR, DRIVE MECH- ANISM, BRAKE AND REEL)	PROVIDES CONSTANT TENSION ON HOOK SWIVEL MOTOR CONTROL CABLE FROM TROLLEY TO LOAD BLOCK.	a. FAILS TO PROVIDE TORQUE b. OPEN/SHORTED MOTOR WINDING, CHAIN DRIVE, MECHANICAL FAILURE c. 09FY12-006.002 d. CABLE UNWINDS e. NONE f. SECONDS g. NA	LOSS OF TORQUE TO CABLE REEL. CABLE WILL UNWIND OFF CABLE REEL, POSSIBLY FALLING ONTO FLIGHT HARDWARE.	POSSIBLE DAMAGE OF A VEHICLE SYSTEM.	2
			a. BRAKE FAILS TO ENGAGE b. BINDING MECHANISM c. 09FY12-006.003 d. CABLE UNWINDS e. NONE f. SECONDS g. NA	CABLE WILL UNWIND OFF CABLE REEL WHEN HOIST STOPS, POSSIBLY FALLING ONTO FLIGHT HARDWARE.	POSSIBLE DAMAGE OF A VEHICLE SYSTEM.	2
			a. BRAKE FAILS TO DISEN- GAGE	THE CABLE WOULD PULL THROUGH BRAKE RESISTANCE WHILE HOOK IS LOWERING BUT WOULD NOT RETRACT WHILE HOOK IS RAISING. DELAY OF OPERATION.	NO EFFECT.	3

MECHANICAL FAILURE MODES AND EFFECTS ANALYSIS

FOR THE

VAB 175-TON BRIDGE CRANE

25-TON AUXILIARY HOIST

PMN: K60-0528

The following components were considered passive in the analysis for this system.

Table 12. **Mechanical Passive Item List**

Hooks	Rope Drums
Trolley Rails	Load Blocks
Bridge Structure	Bridge Drive Truck Wheels
Wire Ropes	Trolley Structure
Sheaves	Trolley Drive Truck Wheels
Bridge Rails	

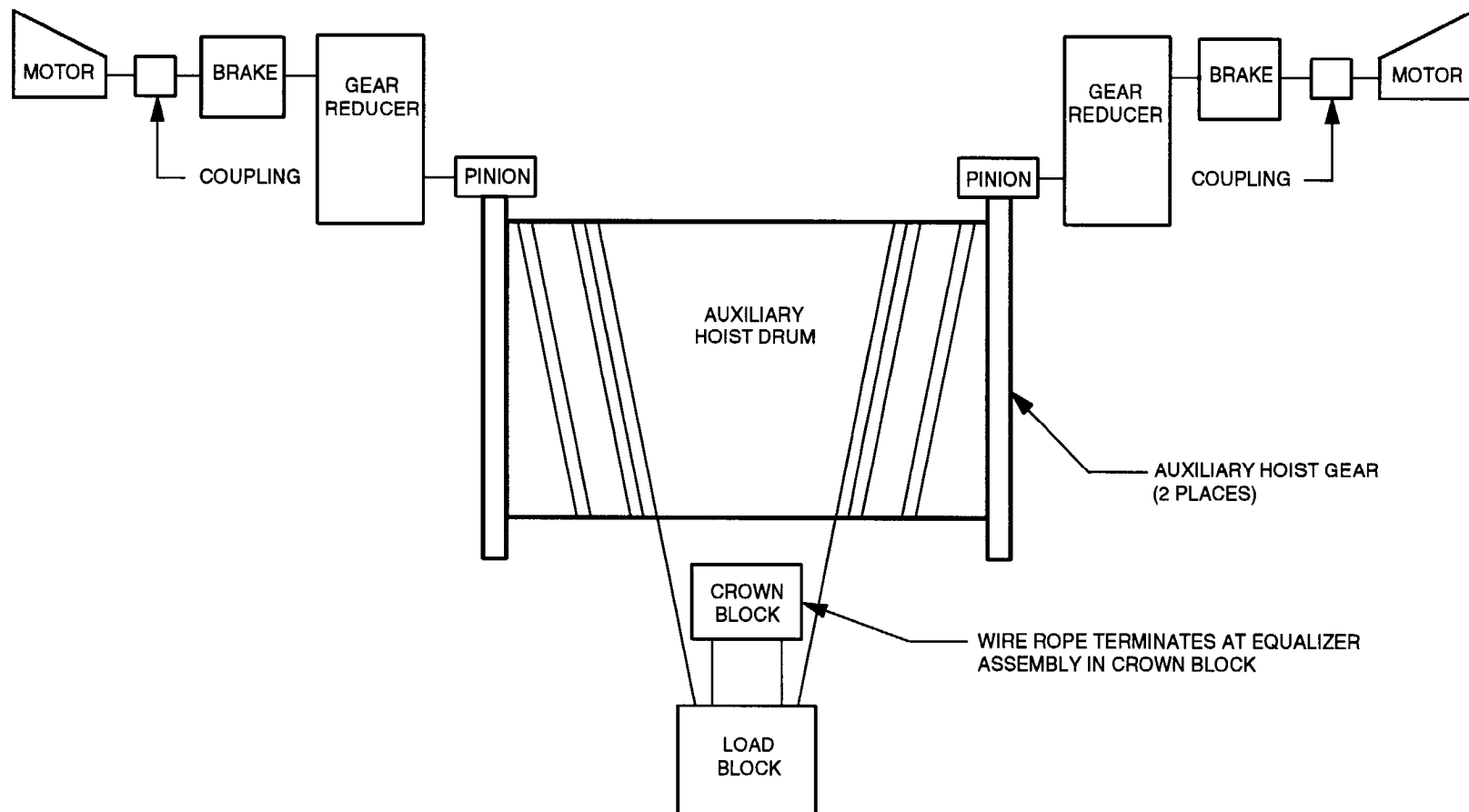


FIGURE 7. AUXILIARY HOIST BLOCK DIAGRAM

Table 13. MECHANICAL FMEA - 25-TON AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem 25-TON AUXILIARY HOIST Drawing No. 79K16830 Sheet No. 2 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 7 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
79K16830/11 IMPERIAL ELECTRIC D69Z SERIAL NO. 285277 (M10 & M11)	DC MOTOR, AUXILIARY HOIST (2 TOTAL)	DRIVES AUXILIARY HOIST.	a. NO OUTPUT DUE TO MECHANICAL FAILURE (ELECTRICAL CIRCUIT REMAINS INTACT)	LOSS OF ABILITY TO CONTROL THE LOAD. REDUNDANT MOTOR CAN CONTROL THE LOAD ON ITS OWN. IF BOTH MOTORS FAILED THE BRAKES CAN BE SET TO CONTROL THE LOAD. MULTIPLE FAILURE REQUIRED TO RESULT IN DAMAGE TO A VEHICLE SYSTEM. DELAY OF OPERATIONS.	NO EFFECT.	3
79K16830/12 GE CR9528 A103-K10AA	AUXILIARY HOIST BRAKE (2 TOTAL)	HOLDS LOAD.	a. FAILS TO ENGAGE	LOSS OF ABILITY TO HOLD THE LOAD. REDUNDANT BRAKE CAN HOLD THE LOAD ON ITS OWN. IF BOTH BRAKES FAILED THE MOTORS CAN CONTROL THE LOAD. MULTIPLE FAILURE REQUIRED TO RESULT IN DAMAGE TO A VEHICLE SYSTEM. DELAY OF OPER- ATIONS.	NO EFFECT.	3
			a. FAILS TO DISENGAGE	UNABLE TO OPERATE HOIST. DELAY IN OPERATIONS.	NO EFFECT.	3
79K16830/19 WESTERN GEAR S61A	AUX. HOIST GEAR TRAIN (2 TOTAL) INCLUDES REDUCER, PINION AND DRUM	TRANSMITS POWER FROM MOTOR TO HOIST DRUM.	a. GEAR DISENGAGEMENT	LOSS OF ABILITY TO HOLD THE LOAD. REDUNDANT AUX. HOIST GEAR TRAIN WILL CARRY LOAD. DELAY IN OPER- ATIONS.	NO EFFECT.	3
79K16830/13 SIER-BATH SIZE 3-1/2 A	AUX. HOIST FLEX COU- PLING (2 TOTAL)	COUPLES MOTOR TO GEAR REDUCER.	a. DISENGAGES	LOSS OF ABILITY TO HOLD THE LOAD. REDUNDANT AUX. HOIST COUPLING WILL CARRY LOAD. DELAY IN OPER- ATIONS.	NO EFFECT.	3

MECHANICAL FAILURE MODES AND EFFECTS ANALYSIS

FOR THE

VAB 175-TON BRIDGE CRANE

TROLLEY ASSEMBLY

PMN: K60-0528

The following components were considered passive in the analysis for this system.

Table 14. **Mechanical Passive Item List**

Hooks	Rope Drums
Trolley Rails	Load Blocks
Bridge Structure	Bridge Drive Truck Wheels
Wire Ropes	Trolley Structure
Sheaves	Trolley Drive Truck Wheels
Bridge Rails	

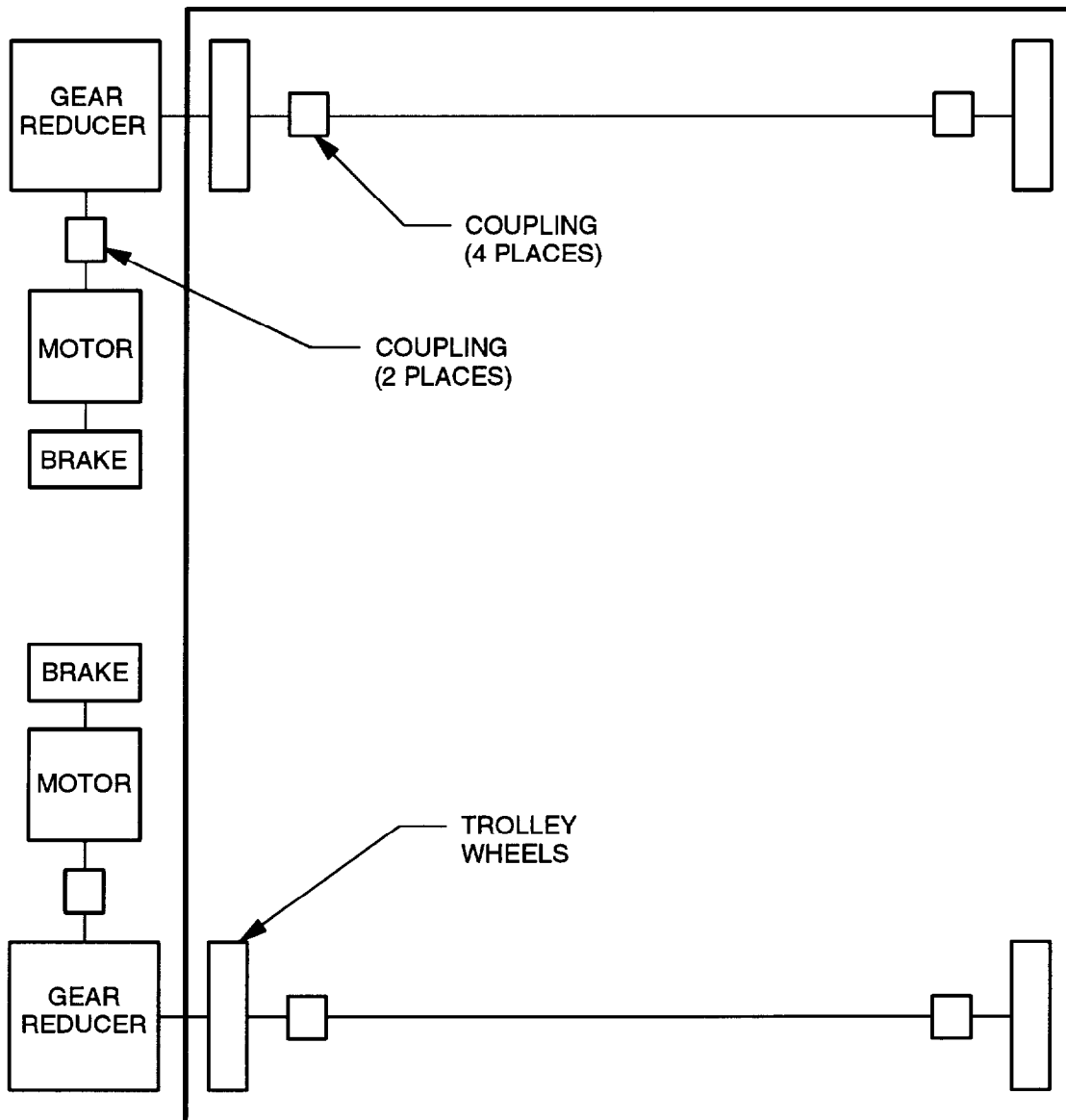


FIGURE 8. TROLLEY DRIVE BLOCK DIAGRAM

Table 15. MECHANICAL FMEA - TROLLEY DRIVE ASSY.						
System 175-TON BRIDGE CRANE, VAB Subsystem TROLLEY DRIVE ASSY. Drawing No. 79K16830 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 8 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
79K16830/20 IMPERIAL ELECTRIC D-35 (M7 & M8)	DC MOTOR, TROLLEY (2 TOTAL)	DRIVES TROLLEY.	a. NO OUTPUT DUE TO MECHANICAL FAILURE (ELECTRICAL CIRCUIT REMAINS INTACT)	LOSS OF POWER TO TROLLEY DRIVE TRUCK. DELAY IN OPERATIONS.	NO EFFECT.	3
79K16830/22 GE 1C9516-161	TROLLEY DRIVE BRAKE (2 TOTAL)	PROVIDES TROLLEY BRAKING FORCE.	a. FAILS TO ENGAGE	REDUNDANT TROLLEY DRIVE BRAKE WILL STOP TROLLEY. DELAY IN OPER- ATIONS.	NO EFFECT.	3
			a. FAILS TO DISENGAGE	UNABLE TO MOVE TROLLEY. DELAY IN OPERATIONS.	NO EFFECT.	3
79K16830/24 SIER-BATH SIZE #2	COUPLING (2 TOTAL)	COUPLES MOTOR. TO GEAR REDUCER.	a. DISENGAGES	LOSS OF POWER TO TROLLEY DRIVE TRUCK. DELAY IN OPERATIONS.	NO EFFECT.	3
79K16830/21 WESTERN GEAR RU700390	TROLLEY DRIVE TRAIN. (2 TOTAL) INCLUDES REDUCER, SHAFT COU- PLINGS, PINION GEARS AND GEARED DRIVE WHEELS.	TRANSMITS POWER FROM MOTOR TO TROLLEY DRIVE WHEELS.	a. DISENGAGEMENT	LOSS OF POWER TO TROLLEY DRIVE TRUCK. DELAY IN OPERATIONS.	NO EFFECT.	3
79K16830/23 SIER-BATH SIZE NO. 3	COUPLING (4 EACH)	COUPLES GEAR REDUCER TO DRIVE SHAFT AND DRIVE SHAFT TO WHEELS.	a. DISENGAGES	LOSS OF POWER TO TROLLEY DRIVE TRUCK. DELAY OF OPERATION.	NO EFFECT.	3

MECHANICAL FAILURE MODES AND EFFECTS ANALYSIS

FOR THE

VAB 175-TON BRIDGE CRANE

BRIDGE DRIVE ASSEMBLY

PMN: K60-0528

The following components were considered passive in the analysis for this system.

Table 16. **Mechanical Passive Item List**

Hooks	Rope Drums
Trolley Rails	Load Blocks
Bridge Structure	Bridge Drive Truck Wheels
Wire Ropes	Trolley Structure
Sheaves	Trolley Drive Truck Wheels
Bridge Rails	

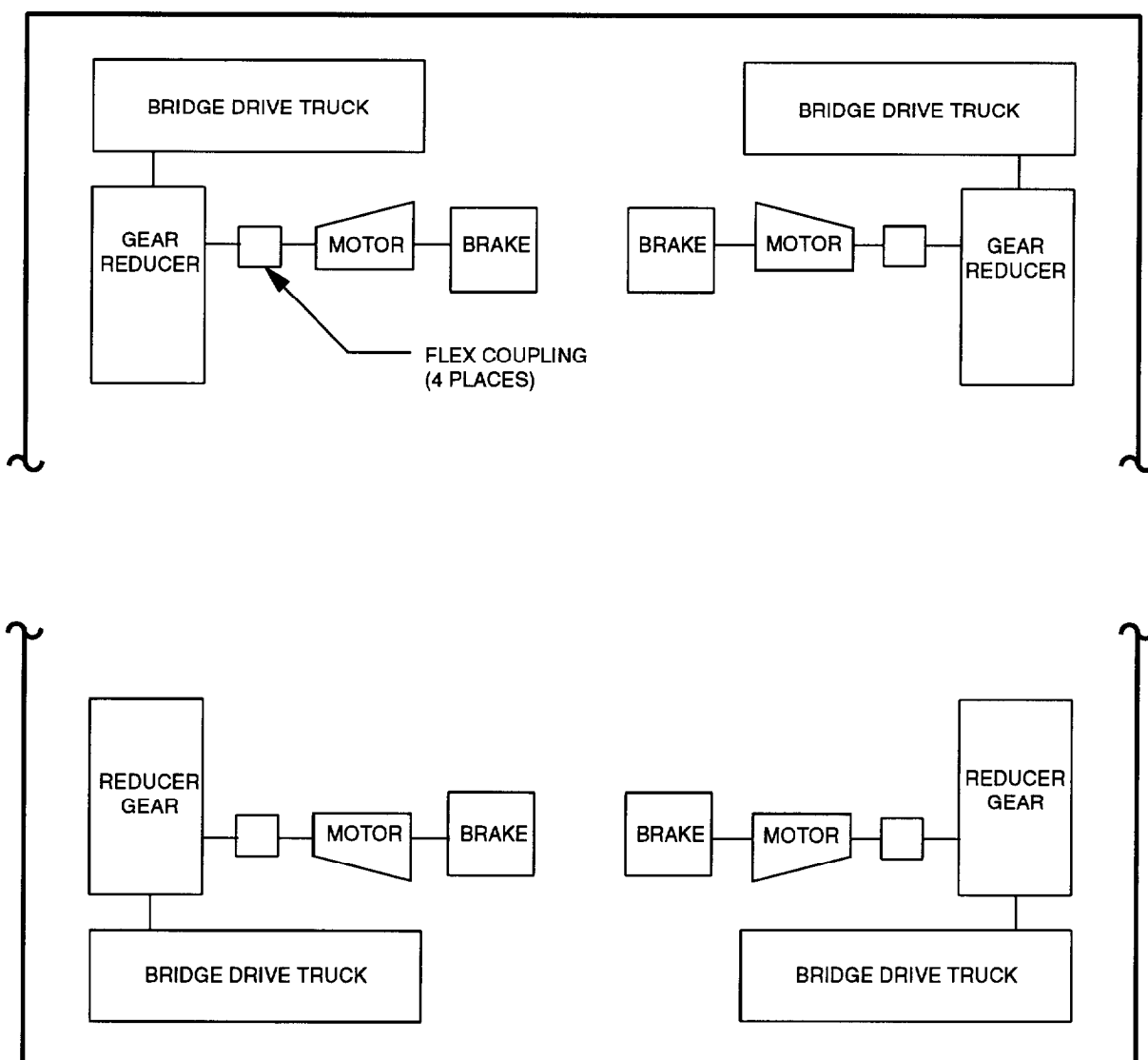


FIGURE 9. BRIDGE DRIVE BLOCK DIAGRAM

Table 17. MECHANICAL FMEA - BRIDGE DRIVE ASSY.						
System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE ASSY. Drawing No. 79K16830 Sheet No. 2 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 9 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
79K16830/25 IMPERIAL ELECTRIC D-37 (M2, M3 M4 & M5)	DC MOTOR, BRIDGE (4 EACH)	DRIVES BRIDGE.	a. NO OUTPUT DUE TO MECHANICAL FAILURE (ELECTRICAL CIRCUIT REMAINS INTACT)	LOSS OF POWER TO BRIDGE DRIVE TRUCK. DELAY IN OPERATIONS.	NO EFFECT.	3
79K16830/27 GE IC9528 A100	BRIDGE DRIVE BRAKE (4 EACH)	PROVIDES BRIDGE BRAKING FORCE.	a. FAILS TO ENGAGE	REMAINING THREE BRIDGE DRIVE TRUCK BRAKES WILL STOP BRIDGE. DELAY IN OPERATIONS.	NO EFFECT.	3
			a. FAILS TO DISENGAGE	UNABLE TO MOVE THE BRIDGE. DELAY IN OPERATIONS.	NO EFFECT.	3
79K16830/28 SIER-BATH TYPE 5 SIZE #2	COUPLING (4 EACH)	COUPLES MOTOR TO GEAR REDUCER.	a. DISENGAGES	LOSS OF POWER TO THE BRIDGE DRIVE TRUCK. DELAY IN OPER- ATIONS.	NO EFFECT.	3
79K16830/26 WESTERN GEAR RU700320	BRIDGE DRIVE GEAR TRAIN (4 EACH) INCLUDES REDUCER, IDLER GEAR AND GEARED DRIVE WHEELS	TRANSMITS POWER FROM MOTOR TO BRIDGE DRIVE TRUCK DRIVE WHEELS.	a. GEAR DISENGAGEMENT	LOSS OF POWER TO THE BRIDGE DRIVE TRUCK. DELAY IN OPER- ATIONS.	NO EFFECT.	3
79K16830/31 SIER-BATH SIZE 3-1/2	COUPLING (4 EACH)	COUPLES GEAR REDUCER TO DRIVE WHEEL.	a. DISENGAGES	LOSS OF POWER TO THE BRIDGE DRIVE WHEEL. DELAY IN OPER- ATIONS.	NO EFFECT.	3

5.2 ELECTRICAL FMEA

The electrical components of the critical functions assessed in section 4.0 for this system were identified from the documents and diagrams referenced in Table 4 on page 15 and are depicted on the following figures and analyzed in the associated Electrical FMEA (Worksheet 5312-005).

ELECTRICAL FAILURE MODES AND EFFECTS ANALYSIS

FOR THE

175-TON BRIDGE CRANE

MAIN HOIST CONTROLS

PMN K60-0528

Failure of any wire harness, cables or connectors that are associated with a criticality category 1 situation are included in the failure cause of the connected critical item identified and will not be listed in the FMEA.

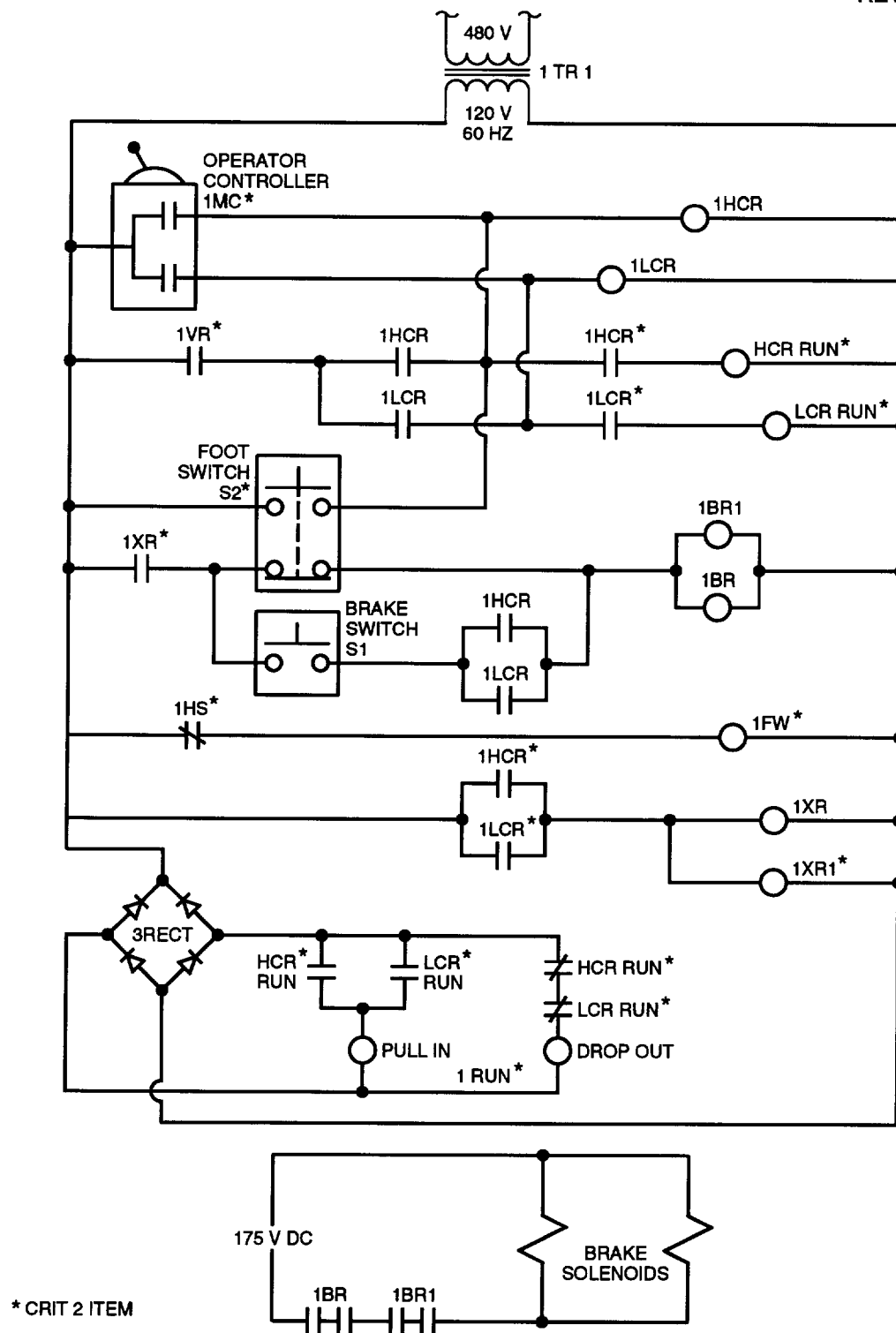


FIGURE 10. MAIN HOIST ELECTRICAL CONTROL SIMPLIFIED SCHEMATIC (1 OF 3)

Table 64 (Page 6 of 11). HAZARD ANALYSIS WORKSHEETS				
Phase/Mode Function 175-TON BRIDGE CRANE			Date JULY 1993	
Task/Operation or Facility VAB			Prepared by J. GARRETT, LSOC 52-11	
HAZARDOUS CONDITION	HAZARD CAUSE	HAZARD EFFECT	SAFETY/ENGINEERING REQUIREMENTS	HAZARD ELIMINATION/CONTROL PROVISIONS
G13 HOIST CONTINUES TO MOVE IN VERTICAL DIRECTION	AND E17 FAILURE OF LOW LEVEL LIMIT SWITCH		E17, E18 NSS/GO 1740.9B, 201g.(10), CRANES USED FOR CRITICAL LIFTS SHALL BE PROVIDED WITH LOWER LIMIT SWITCHES TO PREVENT REVERSE-WINDING OF THE WIRE ROPE; 202, OPERATIONAL TEST REQUIRED; 204b(3), MAINTENANCE REQUIREMENTS FOR LIMIT SWITCHES. OMRSD FILE VI GTAFCRVD0.026 REQUIRES OPERATIONAL TEST.	E17, E18 DOUBLE FAILURE REQUIRED. PERIODIC MAINTENANCE AND INSPECTION INCLUDES MONTHLY OPERATIONAL TEST OF LIMIT SWITCHES, ANNUAL INSPECTION OF LIMIT SWITCHES AND OPERATIONAL TEST UNDER NO LOAD PRIOR TO ANNUAL LOAD TEST PER OMI Q6003. OPERATORS ARE WARNED NOT TO USE LIMIT SWITCHES TO STOP CRANE MOTION PER OMI Q3008. OPERATIONAL TEST OF LIMIT SWITCHES PERFORMED PRIOR TO LIFTS PER OMI Q3008.
	AND E18 FAILURE OF FINAL LOW LEVEL LIMIT SWITCH			
	G14 MOTION FAILS TO STOP WHEN COMMANDED	G11 TWO-BLOCKING	DEVELOPED UNDER HAZARDOUS CONDITION G14.	DEVELOPED UNDER HAZARDOUS CONDITION G14.
	OR E14 OPERATOR/OBSERVER ERROR	AND G12 REVERSE-WINDING	E14 NSS/GO 1740.9B, 205a, ONLY CERTIFIED AND TRAINED OPERATORS SHALL USE/ OPERATE CRANES.	E14 CRITICAL SKILLS VERIFIED FOR CRANE OPERATORS AND OBSERVERS (CSR 019-1, 091-1, 094-1, 019-4, 091-4 AND 094-4) PRIOR TO OPERATIONS PER OMI Q3008. SUPPLEMENTARY OPERATOR INSTRUCTIONS GIVEN IN OMI Q3008, APPENDIX C. EMERGENCY INSTRUCTIONS GIVEN PER OMI Q3008, APPENDIX Z. COMMUNICATIONS CHECK PRIOR TO OPERATIONS PER OMI Q3008.

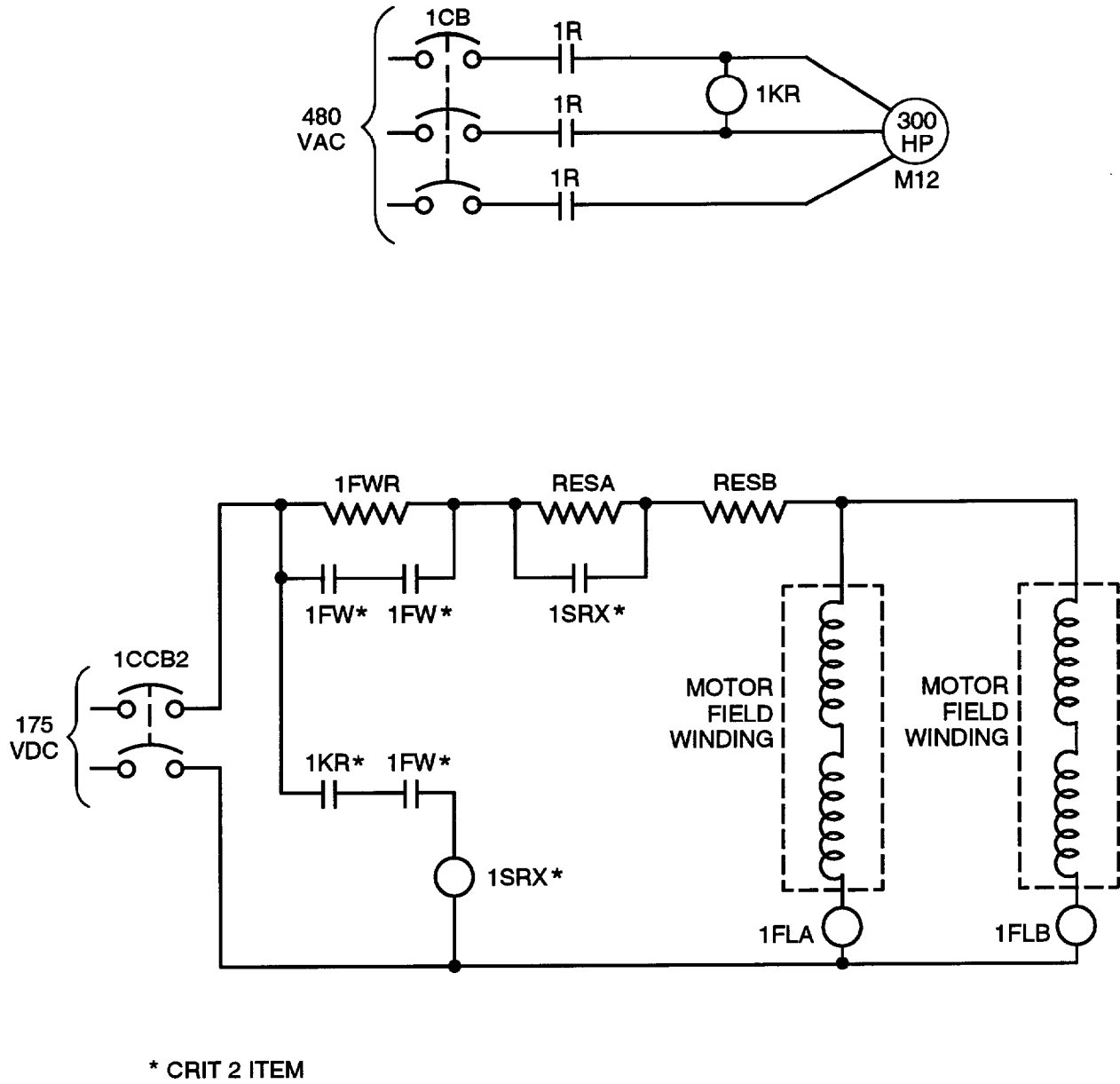


FIGURE 12. MAIN HOIST ELECTRICAL CONTROL SIMPLIFIED SCHEMATIC (3 OF 3)

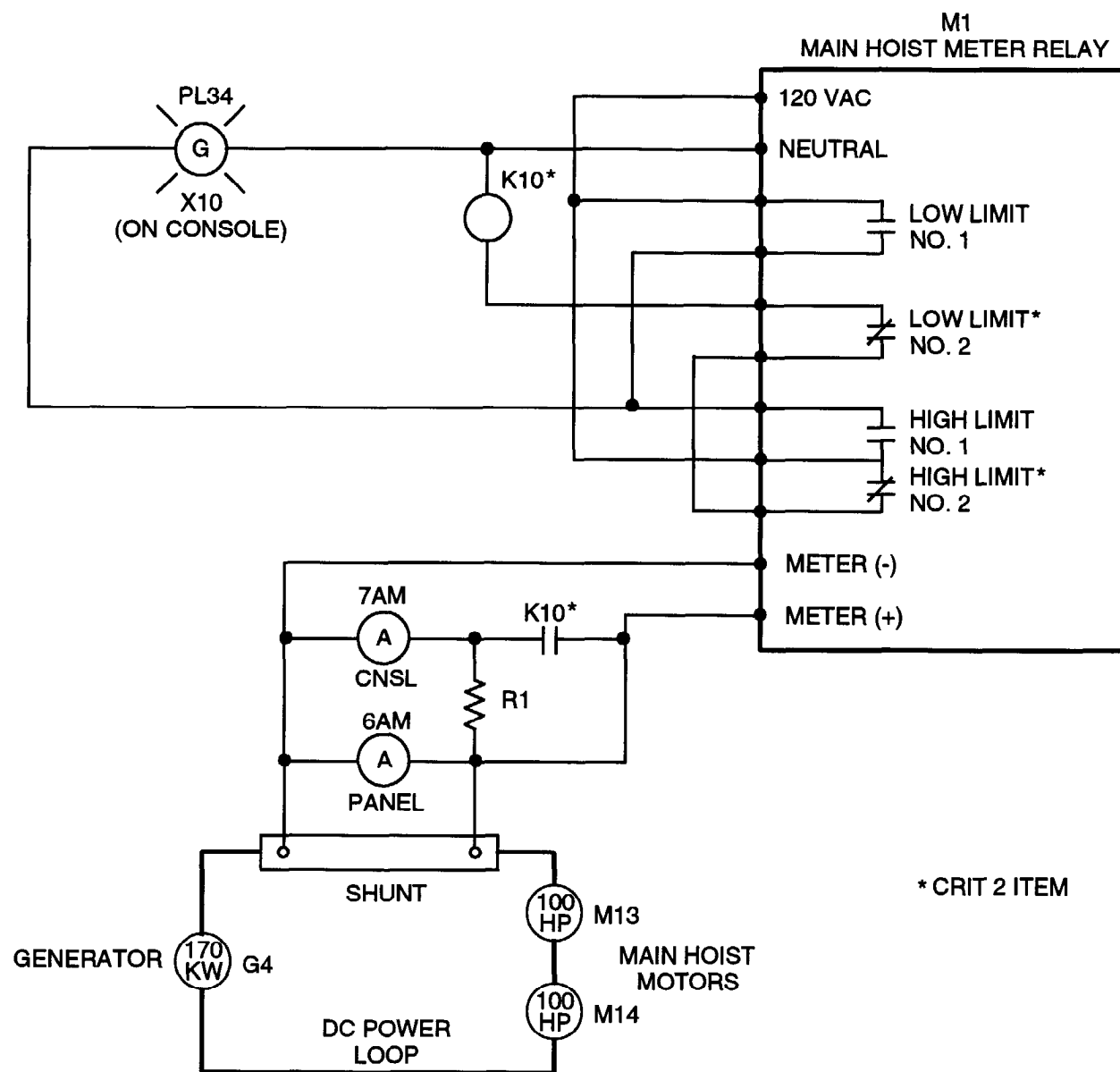


FIGURE 13. MAIN HOIST METER RELAY SCHEMATIC

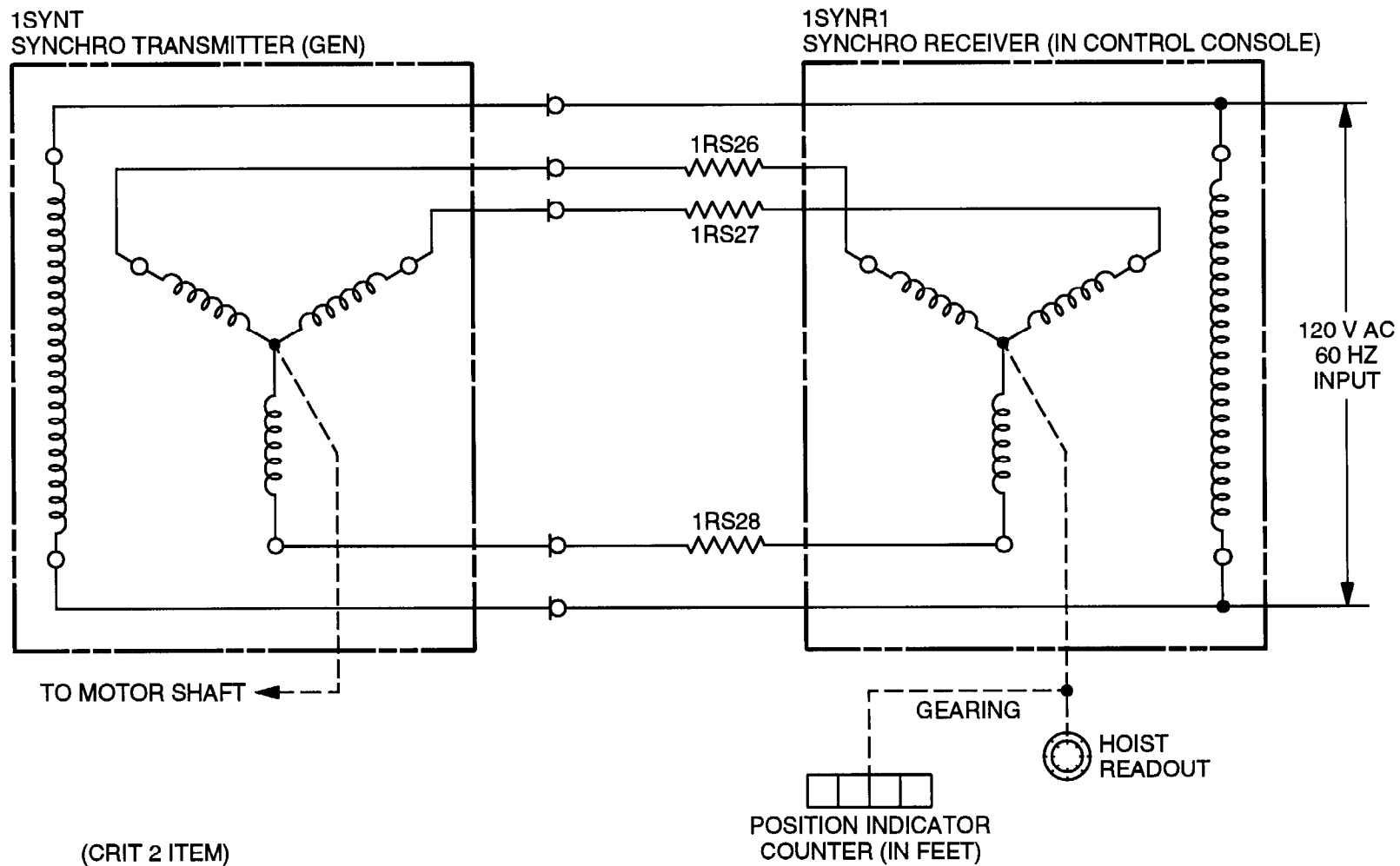


FIGURE 14. MAIN HOIST SYNCHRO TRANSMITTER AND RECEIVER (SELSYN)

Table 18. **ELECTRICAL FMEA - MAIN POWER DISTRIBUTION**

System 175-TON BRIDGE CRANE, VAB Subsystem MAIN POWER DISTRIBUTION Drawing No. 67-K-L-11348 Sheet No. 11/12 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
MCB	MAIN CIRCUIT BREAKER, 1200AT	PROVIDES CIRCUIT OVER- LOAD PROTECTION FOR FEEDER FURNISHING 480V, 3 PHASE, 60 CYCLE POWER FROM SUBSTATION TO BRIDGE CRANE FEEDRAIL.	a. PREMATURE TRIP	LOSS OF POWER TO CRANE. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAILS TO TRIP	POSSIBLE DAMAGE TO CRANE CIRCU- ITRY. CIRCUIT BREAKERS LOCATED DOWNSTREAM, WHICH ARE RATED AT A LOWER AMPERAGE, WOULD TRIP REMOVING POWER FROM THE CRANE. THE BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
		PROVIDES THE ABILITY TO SHUT THE CRANE DOWN AND SET THE BRAKES WHEN THE SHUNT TRIP IS ENERGIZED BY ONE OF THE EMERGENCY STOP (E-STOP) BUTTONS.	a. SHUNT TRIP FAILS OPEN	LOSS OF ABILITY TO SHUT DOWN THE CRANE WITH THE E-STOP BUTTONS WHEN NEEDED IN AN EMERGENCY. THE INDIVIDUAL DRIVE SYSTEMS CAN BE STOPPED BY THE M-G SET STOP BUTTON. MULTIPLE FAILURE REQUIRED TO RESULT IN LOSS OF LIFE, VEHICLE OR DAMAGE TO A VEHICLE SYSTEM.	NO EFFECT.	3
PL1	INDICATOR LIGHT	LIGHTS WHEN THE MAIN CIRCUIT BREAKER (MCB) IS CLOSED AND POWER IS SUP- PLIED TO THE CRANE.	a. FAILS OPEN	OPERATOR WILL NOT HAVE INDI- CATION THAT MAIN CIRCUIT BREAKER IS CLOSED. DELAY IN OPERATION.	NO EFFECT.	3

System 175-TON BRIDGE CRANE, VAB
Subsystem MAIN HOIST
Drawing No. 67-K-L-11348 Sheet No. 12/13/15
PMN K60-0528

Program SPACE SHUTTLE

Station Set/Facility Code TA
Date JULY 1993
Reference Figure Used 11
Prepared By C. CRABB, LSOC 52-11

FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1CB	CIRCUIT BREAKER, 350AT	PROVIDES OVERLOAD PRO- TECTION FOR HOIST CIRCU- ITRY. CONTACT PROVIDES LATCHING FOR START RELAY 1SR.	a. PREMATURE TRIP	LOSS OF POWER TO THE HOIST CONTROL CIRCUITRY. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAILS TO TRIP	POSSIBLE DAMAGE TO HOIST CIRCU- ITRY. UPSTREAM CB (MCB) MAY TRIP RESULTING IN LOSS OF POWER TO MAIN BUS. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	M-G SET WILL NOT STAY RUNNING WHEN START BUTTON IS RELEASED. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	NO EFFECT ON STARTING OR RUNNING M-G SET.	NO EFFECT.	3
		PROVIDES THE ABILITY TO SHUT THE HOIST DOWN AND SET THE BRAKES WHEN THE SHUNT TRIP IS ENERGIZED BY THE PHASE REVERSAL RELAY.	a. SHUNT TRIP FAILS OPEN	LOSS OF ABILITY TO SHUT DOWN THE HOIST BY THE PHASE REVERSAL RELAY. POSSIBLE DAMAGE TO THE CRANE CONTROL CIRCUITRY. MUL- TIPLE FAILURE REQUIRED.	NO EFFECT	3
OL1 OL2 OL3	OVERLOAD	PROVIDES OVERLOAD PRO- TECTION IN EACH OF THE THREE LEGS OF THE MOTOR OF THE M-G SET. THREE N.C. CONTACTS, ARRANGED IN SERIES, OPEN TO SHUT DOWN THE M-G SET.	a. PREMATURE ACTUATION	SHUTDOWN OF THE M-G SET CAUSING HOIST TO STOP. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAILS TO ACTUATE	POSSIBLE DAMAGE TO THE MOTOR IN THE M-G SET. UPSTREAM CB (1CB) MAY TRIP, RESULTING IN LOSS OF POWER TO THE M-G SET. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3

Table 19 (Page 2 of 3). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 Sheet No. 12/13/15 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 11 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
M12-G4	MOTOR- GENERATOR (M-G) SET, 300 HP - 170KW	CONSISTS OF A 300 HP MOTOR COUPLED TO A 170KW DC GENERATOR TO PROVIDE POWER TO THE ARMATURES OF THE TWO 100 HP HOIST MOTORS.	a. N.C. CONTACT FAILS CLOSED	BACKUP CONTACT IN SERIES WILL OPEN TO SHUT DOWN M-G SET.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	M-G WILL NOT RUN. DELAY OF OPER- ATION.	NO EFFECT.	3
			a. NO OUTPUT b. BRUSH/COMMUTATOR FAILURE, OPEN/SHORTED ARMATURE WINDING, STRUCTURAL FAILURE (BRUSH SPRING, BRUSH YOKE, BRUSH RIGGING), OPEN/SHORTED FIELD WINDING, OPEN/SHORTED CABLE OR CONNECTOR. c. 09FY12-006.004 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	LOSS OF HOIST MOTOR ARMATURE CURRENT. LOSS OF HOIST MOTOR TORQUE WHILE THE COMMAND IS BEING GIVEN TO RAISE, LOWER OR FLOAT AND THE BRAKES ARE RELEASED. LOAD WILL DESCEND.	POSSIBLE LOSS OF LIFE AND/OR VEHICLE.	1

Table 19 (Page 3 of 3). **ELECTRICAL FMEA - MAIN HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 Sheet No. 12/13/15 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 11 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
M13, M14	MOTORS, 100 HP EACH	TWO SHUNT WOUND DC MOTORS WITH THE ARMATURES ARRANGED IN SERIES TO PROVIDE MECHANICAL TORQUE TO RAISE, LOWER OR HOLD THE LOAD. THE FIELD WINDINGS, F1-F2 & F3-F4, PROVIDE A CONSTANT MAGNETIC FIELD TO WORK AGAINST THE VARYING MAGNETIC FIELD OF THE ARMATURE LOOP TO PRODUCE TORQUE.	a. OPEN ARMATURE WINDING b. BRUSH/COMMUTATOR FAILURE, OPEN/SHORTED ARMATURE WINDING, STRUCTURAL FAILURE (BRUSH SPRING, BRUSH YOKE, BRUSH RIGGING), OPEN/SHORTED CABLE OR CONNECTOR. c. 09FY12-006.032 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. PRESS E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	LOSS OF ARMATURE DC CURRENT TO BOTH MOTORS. LOSS OF HOIST MOTOR TORQUE WHILE THE COMMAND IS GIVEN TO RAISE, LOWER OR FLOAT LOAD AND THE BRAKES ARE RELEASED. LOAD WILL DESCEND.	POSSIBLE LOSS OF LIFE AND/OR VEHICLE.	1
			a. OPEN FIELD WINDING	RELAY 1FLA OR 1FLB WILL BE DE-ENERGIZED AND OPEN CONTACTS TO SHUT DOWN M-G SET. DELAY OF OPERATION.	NO EFFECT.	3

Table 20. ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 Sheet No. 13 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1-OS1	M-G OVER- SPEED SENSOR	PROVIDES CAPABILITY TO SHUT DOWN THE M-G SET IF AN OVERSPEED CONDITION EXISTS.	a. N.C. CONTACT FAILS CLOSED	LOSS OF M-G OVERSPEED PRO- TECTION. POSSIBLE DAMAGE TO THE M-G SET WHEN COUPLED WITH M-G OVERSPEED.	NO EFFECT.	3
OTG	GENERATOR OVERTEM- PERATURE SENSOR	PROVIDES CAPABILITY TO SHUT DOWN THE M-G SET IF AN OVERTEMPERATURE CON- DITION EXISTS.	a. N.C. CONTACT FAILS OPEN	UNABLE TO START M-G SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	LOSS OF GENERATOR OVERTEMPER- ATURE PROTECTION. POSSIBLE DAMAGE TO THE M-G SET WHEN COUPLED WITH GENERATOR OVER- TEMPERATURE CONDITION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	UNABLE TO START M-G SET. DELAY OF OPERATION.	NO EFFECT.	3

Table 21 (Page 1 of 7). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1CCB	CIRCUIT BREAKER, 30AT	PROVIDE OVERLOAD PRO- TECTION FOR CIRCUIT PRO- VIDING POWER TO THE HOIST M-G SET.	a. PREMATURE TRIP	LOSS OF POWER TO THE HOIST STARTER CONTROLS. THE HOIST WILL STOP. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAIL TO TRIP	POSSIBLE DAMAGE TO THE HOIST CIRCUITRY. UPSTREAM CB (1CB) MAY TRIP. LOSS OF POWER TO THE HOIST M-G SET. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
1TR	RELAY, TIME DELAY	PROVIDES TIMED DELAY FOR DROPPING OUT THE START CIRCUIT AND PICKING UP THE RUN CIRCUIT DURING START OF THE HOIST M-G SET.	a. COIL FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. M-G SET WILL NOT GET FULL POWER. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	M-G SET WILL NOT GET FULL POWER. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	M-G SET WILL GET FULL POWER WHEN START BUTTON IS PUSHED, POSSIBLY CAUSING CURRENT OVERLOAD TO TRIP. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	M-G SET WILL NOT GET FULL POWER. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	M-G SET WILL GET FULL POWER WHEN START BUTTON IS PUSHED, POSSIBLY CAUSING CURRENT OVERLOAD TO TRIP. DELAY OF OPERATION.	NO EFFECT.	3

Table 21 (Page 2 of 7). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 Sheet No. 12/13/15 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1Y	RELAY	CONTROLS STARTING CURRENT FOR THE HOIST M-G SET.	a. COIL FAILS OPEN a. N.O. CONTACT FAILS OPEN (1 OF 2) a. N.O. CONTACT FAILS CLOSED (1 OF 2) a. N.C. CONTACT FAILS CLOSED a. N.C. CONTACT FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. M-G SET WILL NOT START PROPERLY. EXCES- SIVE START-UP CURRENT TO M-G SET, THROUGH RELAY CONTACT 1R (RUN RELAY), WOULD CAUSE M-G SET OVERLOADS TO TRIP. DELAY OF OPERATION. M-G SET WILL NOT START PROPERLY. EXCESSIVE START-UP CURRENT TO M-G SET, THROUGH RELAY CONTACT 1R (RUN RELAY), WOULD CAUSE M-G SET OVERLOADS TO TRIP. DELAY OF OPERATION. CURRENT WILL BYPASS THIS PORTION OF THE CIRCUIT THROUGH RELAY CONTACT 1R (RUN RELAY). NO EFFECT ON CRANE OPERATION. RELAY CONTACT 1S WILL OPEN TO REMOVE POWER FROM THE START CIRCUIT. NO EFFECT ON STARTING OR RUNNING OF M-G SET. M-G SET WOULD NOT GET FULL POWER. DELAY OF OPERATION.	NO EFFECT. NO EFFECT. NO EFFECT. NO EFFECT. NO EFFECT.	3 3 3 3 3
SX	RELAY	ENERGIZES TO PROVIDE CURRENT TO ENERGIZE 1S (START RELAY COILS) FOR M-G START SEQUENCE (4 CONTACTS IN SERIES).	a. COIL FAILS OPEN a. N.O. CONTACT FAILS OPEN (1 OF 4)	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. M-G SET WILL NOT START. DELAY OF OPERA- TION. M-G SET WILL NOT START. DELAY OF OPERATION.	NO EFFECT. NO EFFECT.	3 3

Table 21 (Page 3 of 7). **ELECTRICAL FMEA - MAIN HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
RX	RELAY	ENERGIZES TO PROVIDE CURRENT TO ENERGIZE 1R (RUN RELAY COILS) FOR THE M-G START SEQUENCE (4 CONTACTS IN SERIES).	a. N.O. CONTACT FAILS CLOSED (1 OF 4)	NO EFFECT ON STARTING OR RUNNING OF M-G SET. SERIES ARRANGEMENT INSURES POWER REMOVED FROM START RELAY WHEN NEEDED.	NO EFFECT.	3
			a. COIL FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. LOW POWER TO M-G SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN (1 OF 4).	M-G SET WILL NOT GET FULL POWER. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED (1 OF 4).	NO EFFECT ON STARTING OR RUNNING OF M-G SET. SERIES ARRANGEMENT INSURES POWER REMOVED FROM RUN RELAY WHEN NEEDED.	NO EFFECT.	3
1RS	RESISTOR	PROVIDES A VOLTAGE DIVIDER FOR STARTING RELAY 1S.	a. FAILS OPEN	N.C. RELAY CONTACT OF 1S WILL CHATTER. M-G SET MAY NOT START. DELAY OF OPERATION.	NO EFFECT.	3
2RS	RESISTOR	PROVIDES A VOLTAGE DIVIDER FOR STARTING RELAY 1S.	a. FAILS OPEN	M-G SET WILL NOT START. DELAY OF OPERATION.	NO EFFECT.	3
3RS, 4RS	RESISTOR	RESISTORS ARRANGED IN SERIES TO PROVIDE A VOLTAGE DIVIDER FOR RUN RELAY 1R.	a. FAILS OPEN	N.C. CONTACT OF 1R WILL CHATTER. M-G SET MAY NOT GET FULL POWER. DELAY OF OPERATION.	NO EFFECT.	3
5RS	RESISTOR	PROVIDES A VOLTAGE DIVIDER FOR RUN RELAY 1R.	a. FAILS OPEN	M-G SET WILL NOT GET FULL POWER. DELAY OF OPERATION.	NO EFFECT.	3

Table 21 (Page 4 of 7). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1S	RELAY	CONTROLS STARTING CURRENT FOR THE HOIST M-G SET. TWO COILS ARE ARRANGED IN SERIES (1S-A, 1S-B) TO ENERGIZE CONTACTS. N.O. CONTACTS CLOSE TO PROVIDE THE PROPER START CURRENT TO THE MOTOR IN THE M-G SET (1 CONTACT PER PHASE LEG, 3 TOTAL). N.O. CONTACT CLOSING TO PROVIDE LATCHING FOR RELAY COIL 1SR (HOIST START). ARRANGED IN PARALLEL WITH A CONTACT FROM RELAY 1R TO PROVIDE CONTINUOUS LATCHING THROUGH THE START AND RUN SEQUENCE.	a. COIL FAILS OPEN (1 OF 2). a. N.O. CONTACT FAILS OPEN a. N.O. CONTACT FAILS CLOSED a. N.O. CONTACT FAILS OPEN a. N.O. CONTACT FAILS CLOSED	IF ONE RELAY COIL FAILS OPEN, NEITHER WILL BE ENERGIZED. CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. M-G SET WILL NOT START. DELAY OF OPERATION. M-G SET WILL NOT START PROPERLY. EXCESSIVE START-UP CURRENT TO M-G SET, THROUGH RELAY CONTACT 1R (RUN RELAY), WOULD CAUSE M-G SET OVERLOADS TO TRIP. DELAY OF OPERATION. CURRENT WILL BYPASS THIS PORTION OF THE CIRCUIT THROUGH RELAY CONTACT 1R (RUN RELAY). NO EFFECT ON CRANE OPERATION. IF ALL THREE CONTACTS ARE HELD CLOSED THE M-G SET WILL CONTINUE TO RUN AT A REDUCED VOLTAGE WHEN COMMANDED TO STOP. DELAY OF OPERATIONS. M-G SET WILL SHUT OFF AFTER START BUTTON IS RELEASED. DELAY OF OPERATION. M-G SET WILL RESTART AFTER THE STOP BUTTON IS RELEASED. THE POWER CAN BE REMOVED BY OPENING CIRCUIT BREAKER 1CB. DELAY OF OPERATION.	NO EFFECT. NO EFFECT. NO EFFECT. NO EFFECT.	3 3 3 3

Table 21 (Page 5 of 7). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 Sheet No. 12/13/15 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1R	RELAY	N.C. CONTACT OPENS AFTER COILS 1S-A & 1S-B ARE ENERGIZED TO ALLOW CURRENT TO FLOW THROUGH THE VOLTAGE REGULATING RESISTOR 1RS.	a. N.C. CONTACT FAILS CLOSED	INITIAL ENERGIZING POWER WILL REMAIN TO RELAYS 1S-A, 1S-B. POSSIBLE DAMAGE TO THE RELAYS.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	RELAY COILS 1S-A & 1S-B MAY NOT RECEIVE ENOUGH POWER TO ENERGIZE AND CLOSE THE N.O. CONTACTS FOR STARTING M-G SETS. M-G SET MAY NOT START. DELAY OF OPERATION.	NO EFFECT.	3
		CONTROLS RUNNING CURRENT FOR THE HOIST M-G SET. TWO COILS ARE ARRANGED IN SERIES (1R-A, 1R-B) TO ENERGIZE CONTACTS.	a. COIL FAILS OPEN (1 OF 2).	IF ONE RELAY COIL FAILS OPEN, NEITHER WILL BE ENERGIZED. CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. M-G SET WILL NOT RECEIVE FULL POWER. DELAY OF OPERATION.	NO EFFECT.	3
		N.O. CONTACTS CLOSE TO PROVIDE THE PROPER RUN CURRENT TO THE MOTOR IN THE M-G SET (1 CONTACT PER PHASE LEG, 3 TOTAL).	a. N.O. CONTACT FAILS OPEN	MOTOR WOULD NOT GET THE PROPER RUN CURRENT. M-G SET WILL NOT RECEIVE FULL POWER. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	IF JUST ONE CONTACT IS HELD CLOSED IT COULD CAUSE AN EXCESSIVE START CURRENT WHICH WOULD TRIP M-G SET OVERLOADS. DELAY OF OPERATIONS. OR IF ALL THREE CONTACTS ARE HELD CLOSED THE M-G SET WILL CONTINUE TO RUN WHEN COMMANDED TO STOP. DELAY OF OPERATIONS.	NO EFFECT.	3

Table 21 (Page 6 of 7). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
		N.O. CONTACT CLOSURES TO PROVIDE LATCHING FOR RELAY COIL 1SR (HOIST START). ARRANGED IN PARALLEL WITH A CONTACT FROM RELAY 1S TO PROVIDE CONTINUOUS LATCHING THROUGH THE START AND RUN SEQUENCE.	a. N.O. CONTACT FAILS OPEN a. N.O. CONTACT FAILS CLOSED a. N.C. CONTACT FAILS CLOSED a. N.C. CONTACT FAILS OPEN a. N.C. CONTACT FAILS CLOSED a. N.C. CONTACT FAILS OPEN	M-G SET WILL SHUT OFF AFTER START RELAY 1S IS DEENERGIZED. DELAY OF OPERATION. M-G SET WILL RESTART AFTER THE STOP BUTTON IS RELEASED. THE POWER CAN BE REMOVED BY OPENING CIRCUIT BREAKER 1CB. DELAY OF OPERATION. INITIAL ENERGIZING POWER WILL REMAIN TO RELAYS 1R-A, 1R-B. POSSIBLE DAMAGE TO THE RELAYS. RELAY COILS 1R-A & 1R-B MAY NOT RECEIVE ENOUGH POWER TO ENERGIZE AND CLOSE THE N.O. CONTACTS FOR RUNNING M-G SETS. M-G SET MAY NOT RECEIVE FULL POWER. DELAY OF OPERATION. THE START RELAYS WILL REMAIN ENERGIZED. SERIES ARRANGED CONTACT IN 1TR (TIME DELAY) WILL REMOVE POWER FROM 1Y. THE CRANE WILL OPERATE NORMALLY THROUGH THE RUN CIRCUIT. M-G SET WILL NOT START. DELAY OF OPERATION.	NO EFFECT. NO EFFECT. NO EFFECT. NO EFFECT. NO EFFECT.	3 3 3 3 3
		N.C. CONTACT OPENS AFTER COILS 1R-A & 1R-B ARE ENERGIZED TO ALLOW CURRENT TO FLOW THROUGH THE VOLTAGE REGULATING RESISTORS 3RS & 4RS.				
		N.C. CONTACT OPENS TO DEENERGIZE RELAY SX AND 1Y IN THE STARTING SEQUENCE TO ALLOW THE CRANE TO OPERATE NORMALLY.				

Table 21 (Page 7 of 7). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1 RECT	RECTIFIER, BRIDGE	CONVERTS AC TO DC FOR ENERGIZING RELAY COILS 1S-A AND 1S-B.	a. DIODE FAILS OPEN	REDUCED DC OUTPUT. RELAYS WOULD NOT BE ENERGIZED. M-G SET WILL NOT START. DELAY OF OPERA- TION.	NO EFFECT.	3
			a. DIODE FAILS SHORT	INCREASED CURRENT TO THE RELAY COILS RESULTING IN THE COILS FAILING OPEN. M-G SET WILL NOT START. DELAY OF OPERATION.	NO EFFECT.	3
2 RECT	RECTIFIER, BRIDGE	CONVERTS AC TO DC FOR ENERGIZING RELAY COILS 1R-A AND 1R-B.	a. DIODE FAILS OPEN	REDUCED DC OUTPUT. RELAYS WOULD NOT BE ENERGIZED. M-G SET WOULD NOT RECEIVE FULL POWER. DELAY OF OPERATION.	NO EFFECT.	3
			a. DIODE FAILS SHORT	INCREASED CURRENT TO THE RELAY COILS RESULTING IN THE COILS FAILING OPEN. M-G SET WILL BE SHUT DOWN. DELAY OF OPERATION.	NO EFFECT.	3

Table 22 (Page 1 of 32). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 Sheet No. 12/13/14/15/17/28 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1L1A, 1L2A, 1L3A	AUTOTRANS- FORMER	REGULATES THE STARTING VOLTAGE FOR MOTOR M12 IN THE M-G SET. (1 PER PHASE LEG, 3 TOTAL).	a. FAILS OPEN	MOTOR M12 WILL NOT GET THE PROPER STARTING VOLTAGE. POS- SIBLE DAMAGE TO THE M-G SET. DELAY OF OPERATIONS.	NO EFFECT.	3
1-OTT	AUTOTRANS- FORMER OVERTEM- PERATURE SENSOR	PROVIDES CAPABILITY TO SHUT DOWN THE HOIST M-G SET IF AUTOTRANS- FORMER OVERHEATS.	a. N.C. CONTACT FAILS CLOSED	POSSIBLE DAMAGE TO THE M-G SET. MULTIPLE FAILURE REQUIRED. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	M-G SET WILL NOT START. DELAY OF OPERATION.	NO EFFECT.	3
1TR1	CONTROL TRANS- FORMER	STEPS DOWN THE BUS VOLTAGE OF 480V TO THE DESIRED CONTROL VOLTAGE OF 120V FOR MAIN CONTROL POWER FOR THE HOIST.	a. FAILS OPEN OR SHORT	LOSS OF CONTROL POWER. THE HOIST M-G SET WILL STOP. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
1CCB1	HOIST CONTROL POWER CIRCUIT BREAKER, 15AT	PROVIDES OVERLOAD PRO- TECTION FOR CIRCUIT FUR- NISHING CONTROL POWER FOR THE HOIST.	a. PREMATURE TRIP	LOSS OF CONTROL POWER TO THE HOIST. M-G SET WILL STOP. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAILS TO TRIP	POSSIBLE DAMAGE TO CONTROL CIR- CUITRY. MULTIPLE FAILURE REQUIRED. UPSTREAM CB 1CCB MAY TRIP RESULTING IN LOSS OF POWER TO STARTING AND CONTROL CIR- CUITS. M-G SET WILL STOP. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
S3	PUSH-BUTTON SWITCH, START AND STOP	PROVIDES POWER TO THE HOIST START RELAY 1SR TO START AND STOP THE M-G SET.	a. START SWITCH FAILS OPEN	UNABLE TO START M-G SET. DELAY OF OPERATION.	NO EFFECT.	3

Table 22 (Page 2 of 32). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
PL7	INDICATION LAMP	PROVIDES INDICATION THAT THE HOIST M-G SET STARTING RELAY IS ENER- GIZED.	a. START SWITCH FAILS CLOSED a. STOP SWITCH FAILS CLOSED a. STOP SWITCH FAILS OPEN a. FAILS OPEN	M-G SET WILL RESTART AFTER IT HAS BEEN SHUT DOWN WITH STOP BUTTON. M-G CAN BE SHUT DOWN BY OPENING CB 1CCB OR 1CCB1. UNABLE TO SHUT DOWN M-G SET WITH S3. M-G CAN BE SHUT DOWN BY OPENING CB 1CCB OR 1CCB1. UNABLE TO START M-G SET. DELAY OF OPERATION. UNABLE TO DETERMINE IF STARTING RELAY 1SR IS ENERGIZED. DELAY OF OPERATION.	NO EFFECT. NO EFFECT. NO EFFECT. NO EFFECT.	3 3 3 3
1SR	RELAY	ENABLES THE HOIST CONTROL CIRCUITRY. N.O. CONTACT CLOSSES TO ENABLE THE HOIST MASTER CONTROL 1MC. N.O. CONTACT CLOSSES TO INITIATE AND MAINTAIN THE START AND RUN SEQUENCE FOR THE HOIST M-G SET.	a. COIL FAILS OPEN a. N.O. CONTACT FAILS OPEN a. N.O. CONTACT FAILS CLOSED a. N.O. CONTACT FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. UNABLE TO START M-G SET. DELAY OF OPERA- TION. M-G SET WILL START BUT THE HOIST CANNOT BE MOVED, AND THE BRAKES CANNOT BE RELEASED WITH 1MC. DELAY OF OPERATION. LOSS OF ABILITY TO DISABLE 1MC WITH 1SR. TWO SERIES ARRANGED N.O. RELAY CONTACTS, 1KR & 1KRX, WILL DISABLE 1MC. M-G SET WILL NOT START. DELAY OF OPERATION.	NO EFFECT. NO EFFECT. NO EFFECT. NO EFFECT.	3 3 3 3

Table 22 (Page 3 of 32). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 Sheet No. 12/13/14/15/17/28 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1BR2	RELAY	N.C. CONTACT DISABLES THE OPERATION OF THE AUXILIARY HOIST WHILE THE HOIST IS RUNNING. ENERGIZES WHEN THE HOIST M-G SET IS STARTED TO ENABLE THE BRAKE SOLENOIDS. THE TWO N.O. CONTACTS ARE IN SERIES WITH 1BR AND 1BR1 CONTACTS.	a. N.O. CONTACT FAILS CLOSED	UNABLE TO SHUT DOWN M-G SET WITH STOP BUTTON. M-G SET CAN BE SHUT DOWN BY OPENING CIRCUIT BREAKER 1CCB.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	UNABLE TO START AUX. HOIST. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	WILL NOT LOCK-OUT AUX. HOIST WHILE MAIN HOIST IS OPERATING. NO EFFECT ON MAIN HOIST OPERATION.	NO EFFECT.	3
			a. COIL FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. BRAKES WILL REMAIN SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN (1 OF 2)	BRAKES WILL REMAIN SET. DELAY OF OPERATION.	NO EFFECT.	3
1MB	RELAY	ENERGIZES TO TURN ON BLOWER MOTORS, M17 & M18, WHEN THE M-G SET IS STARTED.	a. N.O. CONTACT FAILS CLOSED (1 OF 2)	THE REDUNDANT CONTACTS IN SERIES WILL OPEN, REMOVING POWER FROM BRAKES TO SET THEM.	NO EFFECT.	3
			a. COIL FAILS OPEN	CONTACTS REMAIN IN DEENERGIZED POSITION. THE BLOWER MOTORS WILL NOT START. POSSIBLE DAMAGE TO THE DC DRIVE MOTORS. THE HOIST MOTOR WINDING TEMPERATURE SENSOR WILL SHUT DOWN THE HOIST M-G SET IF NECESSARY.	NO EFFECT.	3

Table 22 (Page 4 of 32). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 Sheet No. 12/13/14/15/17/28 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1MC	MASTER CONTROL SWITCH	A "JOYSTICK" CONNECTED TO MECHANICAL CONTACTS AND REFERENCE POTENTIOMETER (RPOT), TO PROVIDE THE OPERATOR CONTROL OF THE HOIST FOR RAISING (1MC-3) OR LOWERING (1MC-2) THE LOAD AND RELEASING THE BRAKES BY ENERGIZING THE HOIST CONTROL OR LOWER CONTROL RELAYS IN THE NORMAL MODE OF OPERATION.	a. N.O. CONTACT FAILS OPEN (1 OF 3)	BLOWER MOTORS WILL NOT RECEIVE FULL POWER. POSSIBLE DAMAGE TO THE BLOWER MOTORS AND THE DC DRIVE MOTORS. THE HOIST MOTOR WINDING TEMPERATURE SENSOR WILL SHUT DOWN THE HOIST M-G SET IF NECESSARY.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED (1 OF 3)	NO EFFECT. BLOWER MOTORS WILL SHUT OFF AS EXPECTED.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	UNABLE TO DRIVE THE HOIST MOTORS AND RELEASE THE BRAKES FOR NORMAL OPERATIONS. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED b. WELDED CONTACT, BINDING MECHANISM c. 09FY12-006.005 d. BRAKE SET LIGHT WILL NOT COME ON e. PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	BRAKES WILL NOT SET WHEN MASTER CONTROL LEVER IS RETURNED TO NEUTRAL POSITION (NO ARMATURE CURRENT). LOAD WILL DESCEND WITH REGENERATIVE BRAKING APPLIED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2

Table 22 (Page 5 of 32). **ELECTRICAL FMEA - MAIN HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1HCR	RELAY	N.C. CONTACT (1MC-1) OPENS WHEN THE "JOYSTICK" IS POSITIONED OUT OF DETENT TO PREVENT THE M-G SET FROM BEING STARTED.	a. N.C. CONTACT FAILS OPEN	UNABLE TO START THE M-G SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	M-G SET CAN BE STARTED WITH THE "JOYSTICK" OUT OF DETENT. OPERATOR ERROR REQUIRED.	NO EFFECT.	3
		N.O. CONTACT (1MC-4) CLOSSES TO ENERGIZE THE HIGH SPEED RELAYS WHEN THAT MODE IS SELECTED.	a. N.O. CONTACT FAILS OPEN	LOSS OF HIGH SPEED CAPABILITY. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	SPEED SELECTOR SWITCH CONTACT, SS2-5, ARRANGED IN SERIES, WILL PREVENT THE HIGH SPEED RELAYS FROM BEING ENERGIZED IF THE HIGH SPEED MODE IS NOT SELECTED.	NO EFFECT.	3
		PROVIDES POWER TO BRAKE RELAYS TO RELEASE BRAKES DURING HOISTING AND FLOATING OPERATIONS, AND PROVIDES POWER TO START THE SEQUENCE TO ENERGIZE THE GENERATOR FIELD WINDING.	a. COIL FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. BRAKES CANNOT BE RELEASED AND GENERATOR FIELD CANNOT BE ENERGIZED. DELAY OF OPERATION.	NO EFFECT.	3

Table 22 (Page 6 of 32). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
		N.O. CONTACT CLOSSES TO ENERGIZE HCR RUN WHICH ENERGIZES 1RUN.	a. N.O. CONTACT FAILS OPEN b. CORROSION, BINDING MECHANISM c. 09FY12-006.006 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. RETURN THE MASTER CONTROLLER TO NEUTRAL OR PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	RELAY 1RUN N.O. CONTACT WILL NOT CLOSE AND GENERATOR FIELD WILL NOT BE ENERGIZED. NO HOIST MOTOR TORQUE. LOAD WILL DESCEND, WITH REGENERATIVE BRAKING APPLIED, WHILE THE COMMAND IS BEING GIVEN TO RAISE OR FLOAT AND THE BRAKES ARE RELEASED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. N.O. CONTACT FAILS CLOSED	POWER WILL BE REMOVED FROM RELAY HCR RUN WHEN THE MASTER CONTROL SWITCH IS RETURNED TO CENTER AND SERIES RELAY CONTACT 1VR IS DEENERGIZED.	NO EFFECT.	3
		N.O. CONTACT, ARRANGED IN SERIES WITH 1VR, CLOSSES TO KEEP RELAY 1HCR ENERGIZED WHILE THE VOLTAGE IN THE DC DRIVE MOTOR CIRCUIT IS ABOVE A PREDETERMINED LIMIT. THIS PREVENTS THE BRAKES FROM SETTING, AFTER THE MASTER CONTROL SWITCH IS RETURNED TO NEUTRAL, WHILE THE MOTORS WIND DOWN.	a. N.O. CONTACT FAILS OPEN	BRAKES WILL SET IMMEDIATELY WHEN THE MASTER CONTROL SWITCH IS RETURNED TO NEUTRAL. POSSIBLE DAMAGE TO THE BRAKES.	NO EFFECT.	3

Table 22 (Page 7 of 32). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
		N.O. CONTACT CLOSURES TO ENERGIZE RELAY 1XR, WHICH RELEASES THE BRAKES, AND RELAY 1XR1, WHICH ENABLES THE GENERATOR FIELD DC INPUT CONTROLLER.	a. N.O. CONTACT FAILS CLOSED a. N.O. CONTACT FAILS OPEN	SERIES ARRANGEMENT OF 1VR N.O. CONTACT WILL REMOVE POWER FROM 1HCR AFTER THE VOLTAGE IN THE DC MOTOR CIRCUIT GOES BELOW THE PREDETERMINED LIMIT. BRAKES WILL NOT BE RELEASED AND THE GENERATOR FIELD DC INPUT CONTROLLER WILL NOT BE ENABLED. DELAY OF OPERATIONS.	NO EFFECT. NO EFFECT.	3 3
		N.O. CONTACT CLOSURES TO ENABLE THE HAND BRAKE RELEASE SWITCH S1.	a. N.O. CONTACT FAILS CLOSED b. WELDED CONTACTS, BINDING MECHANISM c. 09FY12-006.007 d. BRAKE SET LIGHT WILL NOT COME ON e. PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	BRAKE RELAYS WILL REMAIN ENER- GIZED AND BRAKES WILL NOT SET WHEN HOIST MOTORS ARE COM- MANDED TO STOP (IN NORMAL OPER- ATION). LOAD WILL DESCEND WITH REGENERATIVE BRAKING APPLIED. GENERATOR FIELD DC INPUT CON- TROLLER WILL BE ENABLED BUT DEENERGIZED 1RUN CONTACT WILL PREVENT AN INPUT TO THE GENER- ATOR FIELD WINDING.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
		N.C. CONTACT OPENS TO DISABLE THE LOWERING PORTION OF THE CIRCUITRY.	a. N.O. CONTACT FAILS OPEN a. N.O. CONTACT FAILS CLOSED a. N.C. CONTACT FAILS OPEN	HAND BRAKE SWITCH S1 CANNOT RELEASE THE BRAKES. DELAY OF OPERATION. HAND BRAKE SWITCH S1 AND N.O. RELAY CONTACT 1XR, ARRANGED IN SERIES, WILL PREVENT THE BRAKES FROM BEING RELEASED INADVERT- ENTLY. RELAY 1LCR WILL REMAIN LOCKED OUT. UNABLE TO LOWER LOAD. DELAY OF OPERATION.	NO EFFECT. NO EFFECT. NO EFFECT.	3 3 3

Table 22 (Page 8 of 32). **ELECTRICAL FMEA - MAIN HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 Sheet No. 12/13/14/15/17/28 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1LCR	RELAY	PROVIDES POWER TO BRAKE RELAYS TO RELEASE BRAKES DURING LOWERING OPER- ATIONS, AND PROVIDES POWER TO START THE SEQUENCE TO ENERGIZE THE GENERATOR FIELD WINDING. N.O. CONTACT CLOSSES TO ENERGIZE LCR RUN WHICH ENERGIZES 1RUN.	a. N.C. CONTACT FAILS CLOSED	RELAY 1LCR WILL NOT BE LOCKED OUT. NO EFFECT ON HOISTING OPER- ATIONS.	NO EFFECT.	3
			a. COIL FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. BRAKES CANNOT BE RELEASED AND GENER- ATOR FIELD CANNOT BE ENERGIZED. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN b. CORROSION, BINDING MECHANISM c. 09FY12-006.008 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. RETURN THE MASTER CONTROLLER TO NEUTRAL OR PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	RELAY 1RUN N.O. CONTACT WILL NOT CLOSE AND GENERATOR FIELD WILL NOT BE ENERGIZED. NO HOIST MOTOR TORQUE. LOAD WILL DESCEND, WITH REGENERATIVE BRAKING APPLIED, WHILE THE COMMAND, VIA THE MASTER CONTROL SWITCH, IS BEING GIVEN TO LOWER AND THE BRAKES ARE RELEASED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. N.O. CONTACT FAILS CLOSED	POWER WILL BE REMOVED FROM RELAY LCR RUN WHEN THE MASTER CONTROL SWITCH IS RETURNED TO CENTER AND SERIES RELAY CONTACT 1VR IS DEENERGIZED.	NO EFFECT.	3

Table 22 (Page 9 of 32). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
		N.O. CONTACT, ARRANGED IN SERIES WITH 1VR, CLOSING TO KEEP RELAY 1LCR ENERGIZED WHILE THE VOLTAGE IN THE DC DRIVE MOTOR CIRCUIT IS ABOVE A PREDETERMINED LIMIT. THIS PREVENTS THE BRAKES FROM SETTING, AFTER THE MASTER CONTROL SWITCH IS RETURNED TO NEUTRAL, WHILE THE MOTORS WIND DOWN.	a. N.O. CONTACT FAILS OPEN	BRAKES WILL SET IMMEDIATELY WHEN THE MASTER CONTROL SWITCH IS RETURNED TO NEUTRAL. POSSIBLE DAMAGE TO THE BRAKES.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	SERIES ARRANGEMENT OF 1VR N.O. CONTACT WILL REMOVE POWER FROM 1LCR AFTER THE VOLTAGE IN THE DC MOTOR CIRCUIT GOES BELOW THE PREDETERMINED LIMIT.	NO EFFECT.	3
		N.O. CONTACT CLOSING TO ENERGIZE RELAY 1XR, WHICH RELEASES THE BRAKES, AND RELAY 1XR1, WHICH ENABLES THE GENERATOR FIELD DC INPUT CONTROLLER.	a. N.O. CONTACT FAILS OPEN	BRAKES WILL NOT BE RELEASED AND THE GENERATOR FIELD DC INPUT CONTROLLER WILL NOT BE ENABLED. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED b. WELDED CONTACTS, BINDING MECHANISM c. 09FY12-006.009 d. BRAKE SET LIGHT WILL NOT COME ON e. PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	BRAKE RELAYS WILL REMAIN ENERGIZED AND BRAKES WILL NOT SET WHEN HOIST MOTORS ARE COMMANDED TO STOP (IN NORMAL OPERATION). LOAD WILL DESCEND WITH REGENERATIVE BRAKING APPLIED. GENERATOR FIELD DC INPUT CONTROLLER WILL BE ENABLED BUT DEENERGIZED 1RUN CONTACT WILL PREVENT AN INPUT TO THE GENERATOR FIELD WINDING.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2

Table 22 (Page 10 of 32). **ELECTRICAL FMEA - MAIN HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1HLS	HIGH LEVEL LIMIT SWITCH	N.O. CONTACT CLOSURES TO ENABLE THE HAND BRAKE RELEASE SWITCH S1.	a. N.O. CONTACT FAILS OPEN	HAND BRAKE SWITCH S1 CANNOT RELEASE THE BRAKES. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	HAND BRAKE SWITCH S1 AND N.O. RELAY CONTACT 1XR, ARRANGED IN SERIES, WILL PREVENT THE BRAKES FROM BEING RELEASED INADVERT- ENTLY.	NO EFFECT.	3
		N.C. CONTACT OPENS TO DISABLE THE HOISTING PORTION OF THE CIRCUITRY.	a. N.C. CONTACT FAILS OPEN	RELAY 1HCR WILL REMAIN LOCKED OUT. UNABLE TO HOIST LOAD. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	RELAY 1HCR WILL NOT BE LOCKED OUT. NO EFFECT ON LOWERING OPER- ATIONS.	NO EFFECT.	3
		SHUTS DOWN THE HOIST AND SETS THE BRAKES IN THE EVENT THE UPPER LEVEL OF TRAVEL IS REACHED.	a. N.C. CONTACT FAILS OPEN	UNABLE TO OPERATE THE HOIST IN THE HOIST DIRECTION ONLY. IT WILL STILL OPERATE IN THE LOWER MODE. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	POSSIBLE DAMAGE TO THE WIRE ROPE. MULTIPLE FAILURE OR OPER- ATOR ERROR REQUIRED.	NO EFFECT.	3
1LLS-A	LOW LEVEL LIMIT SWITCH	SHUTS DOWN THE HOIST AND SETS THE BRAKES IN THE EVENT THE FIRST LOWER LIMIT OF TRAVEL IS REACHED.	a. N.C. CONTACT FAILS OPEN	UNABLE TO OPERATE THE HOIST IN THE LOWER DIRECTION ONLY. IT WILL STILL OPERATE IN THE HOIST MODE. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	POSSIBLE DAMAGE TO THE WIRE ROPE. MULTIPLE FAILURE OR OPER- ATOR ERROR REQUIRED.	NO EFFECT.	3

Table 22 (Page 11 of 32). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1LLS-B	LOW LEVEL LIMIT SWITCH	SHUTS DOWN THE HOIST AND SETS THE BRAKES IN THE EVENT THE SECOND LOWER LIMIT IS REACHED DURING FLOAT OPERATION.	a. N.C. CONTACT FAILS OPEN	UNABLE TO USE FLOAT MODE. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	POSSIBLE DAMAGE TO THE WIRE ROPE. MULTIPLE FAILURE OR OPER- ATOR ERROR REQUIRED.	NO EFFECT.	3
1HSTR	TIME DELAY RELAY	PROVIDES TIMED DELAY FOR ENERGIZING HIGH SPEED RELAY 1HS.	a. COIL FAILS OPEN	CONTACT REMAINS IN DE-ENERGIZED POSITION. UNABLE TO ENERGIZE HIGH SPEED RELAY AND ACHIEVE HIGH SPEED TRAVEL.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	UNABLE TO ENERGIZE HIGH SPEED RELAY AND ACHIEVE HIGH SPEED TRAVEL.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	SPEED SELECTOR SWITCH CONTACT, SS2-5, ARRANGED IN SERIES, WILL PREVENT THE HIGH SPEED RELAY FROM BEING ENERGIZED IF THE HIGH SPEED MODE IS NOT SELECTED.	NO EFFECT.	3
1HS	RELAY	ENERGIZES TO PROVIDE HIGH SPEED OPERATION OF THE HOIST.	a. COIL FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. LOSS OF HIGH SPEED RANGE.	NO EFFECT.	3
		N.O. CONTACT CLOSURES TO PROVIDE A REDUNDANT POWER PATH TO THE BRAKE RELAYS TO RELEASE THE BRAKES.	a. N.O. CONTACT FAILS OPEN	PARALLEL ARRANGED CONTACT OF RELAY 1XR WILL PROVIDE A POWER PATH TO RELEASE THE BRAKES.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	SERIES ARRANGED CONTACT OF RELAY 1XR WILL OPEN AND SET THE BRAKES.	NO EFFECT.	3

Table 22 (Page 12 of 32). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
HCR RUN	RELAY	N.C. CONTACT OPENS TO DEENERGIZE THE FIELD WEAKENING RELAY, 1FW, TO WEAKEN THE FIELD OF THE DC DRIVE MOTORS AND PUT THE HOIST IN THE HIGH SPEED MODE CONFIGURATION.	a. N.C. CONTACT FAILS OPEN b. CORROSION, BINDING MECHANISM c. 09FY12-006.098 d. SELSYN POSITION INDICATOR e. PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	THE N.C. CONTACT WILL OPEN, DEENERGIZING RELAY 1FW, WHICH PLACES RESISTORS 1FWR AND RESA IN SERIES WITH THE DC MOTOR FIELD WINDINGS. THE FIELD WILL BE WEAKENED BY THE REDUCTION OF CURRENT THROUGH THE WINDINGS. THE HOIST WILL BE IN THE HIGH SPEED MODE CONFIGURATION. THE HOIST SPEED WILL INCREASE TO APPROXIMATELY THREE TIMES THE COMMANDED SPEED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
		CONTROLS RELAY 1RUN FOR ENERGIZING THE GENERATOR FIELD WINDING DURING HOISTING OR FLOAT OPERATIONS.	a. N.C. CONTACT FAILS CLOSED	LOSS OF HIGH SPEED RANGE. NO EFFECT ON NORMAL OPERATIONS.	NO EFFECT.	3
			a. COIL FAILS OPEN b. CORROSION, FATIGUE c. 09FY12-006.010 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. RETURN THE MASTER CONTROLLER TO NEUTRAL OR PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	CONTACTS REMAIN IN DE-ENERGIZED POSITION. RELAY 1RUN N.O. CONTACT WILL NOT CLOSE AND THE GENERATOR FIELD WINDING WILL NOT BE ENERGIZED. NO HOIST MOTOR TORQUE. LOAD WILL DESCEND, WITH REGENERATIVE BRAKING APPLIED, WHILE THE COMMAND IS BEING GIVEN TO RAISE OR FLOAT AND THE BRAKES ARE RELEASED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2

Table 22 (Page 13 of 32). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
			a. N.O. CONTACT FAILS OPEN b. CORROSION, BINDING MECHANISM c. 09FY12-008.011 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. RETURN THE MASTER CONTROLLER TO NEUTRAL OR PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	RELAY 1RUN N.O. CONTACT WILL NOT CLOSE AND THE GENERATOR FIELD WINDING WILL NOT BE ENERGIZED. NO HOIST MOTOR TORQUE. LOAD WILL DESCEND, WITH REGENERATIVE BRAKING APPLIED, WHILE THE COMMAND IS GIVEN TO RAISE OR FLOAT AND THE BRAKES ARE RELEASED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. N.O. CONTACT FAILS CLOSED	RELAY 1RUN N.O. CONTACT WILL REMAIN CLOSED WHEN THE JOYSTICK IS RETURNED TO CENTER. THERE WILL BE NO INPUT TO THE GENERATOR FIELD WINDING BECAUSE THE GENERATOR FIELD DC INPUT CONTROLLER WILL BE DISABLED.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED b. WELDED CONTACTS, BINDING MECHANISM c. 09FY12-008.012 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. RETURN THE MASTER CONTROLLER TO NEUTRAL OR PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	RELAY 1RUN N.O. CONTACT WILL NOT CLOSE AND THE GENERATOR FIELD WINDING WILL NOT BE ENERGIZED. NO HOIST MOTOR TORQUE. LOAD WILL DESCEND, WITH REGENERATIVE BRAKING APPLIED, WHILE THE COMMAND IS GIVEN TO RAISE OR FLOAT AND THE BRAKES ARE RELEASED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2

Table 22 (Page 14 of 32). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
LCR RUN	RELAY	CONTROLS RELAY 1RUN FOR ENERGIZING THE GENERATOR FIELD WINDING DURING LOWERING OPERATIONS.	a. N.C. CONTACT FAILS OPEN	RELAY 1RUN N.O. CONTACT WILL DROP OUT (OPEN) BY GRAVITY AND/OR THE SPRING FORCE.	NO EFFECT.	3
			a. COIL FAILS OPEN b. CORROSION, FATIGUE c. 09FY12-006.013 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. RETURN THE MASTER CONTROLLER TO NEUTRAL OR PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	CONTACTS REMAIN IN DE-ENERGIZED POSITION. RELAY 1RUN N.O. CONTACT WILL NOT CLOSE AND THE GENERATOR FIELD WINDING WILL NOT BE ENERGIZED. NO HOIST MOTOR TORQUE. LOAD WILL DESCEND, WITH REGENERATIVE BRAKING APPLIED, WHEN THE COMMAND, VIA THE MASTER CONTROL SWITCH, IS GIVEN TO LOWER AND THE BRAKES ARE RELEASED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. N.O. CONTACT FAILS OPEN b. CORROSION, BINDING MECHANISM c. 09FY12-006.014 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. RETURN THE MASTER CONTROLLER TO NEUTRAL OR PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	RELAY 1RUN N.O. CONTACT WILL NOT CLOSE AND THE GENERATOR FIELD WINDING WILL NOT BE ENERGIZED. NO HOIST MOTOR TORQUE. LOAD WILL DESCEND, WITH REGENERATIVE BRAKING APPLIED, WHEN THE COMMAND, VIA THE MASTER CONTROL SWITCH IS GIVEN TO LOWER AND THE BRAKES ARE RELEASED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2

Table 22 (Page 15 of 32). **ELECTRICAL FMEA - MAIN HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1XR	RELAY	ENERGIZES WHEN RELAY 1HCR OR 1LCR IS ENERGIZED BY THE MASTER CON- TROLLER TO PROVIDE POWER TO THE BRAKE RELAYS 1BR & 1BR1 TO RELEASE THE BRAKES.	a. N.O. CONTACT FAILS CLOSED	RELAY 1RUN N.O. CONTACT WILL REMAIN CLOSED WHEN THE JOYSTICK IS RETURNED TO CENTER. THERE WILL BE NO INPUT TO THE GENER- ATOR FIELD WINDING BECAUSE THE GENERATOR FIELD DC INPUT CON- TROLLER WILL BE DISABLED.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED b. WELDED CONTACTS, BINDING MECHANISM c. 09FY12-006.015 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. RETURN THE MASTER CONTROLLER TO NEUTRAL OR PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	RELAY 1RUN N.O. CONTACT WILL NOT CLOSE AND THE GENERATOR FIELD WINDING WILL NOT BE ENERGIZED. NO HOIST MOTOR TORQUE. LOAD WILL DESCEND, WITH REGENERATIVE BRAKING APPLIED, WHEN THE COMMAND, VIA THE MASTER CONTROL SWITCH, IS GIVEN TO LOWER AND THE BRAKES ARE RELEASED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. N.C. CONTACT FAILS OPEN	RELAY 1RUN N.O. CONTACT WILL DROP OUT (OPEN) BY GRAVITY AND/OR THE SPRING FORCE.	NO EFFECT.	3
			a. COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. UNABLE TO ENERGIZE BRAKE RELAYS AND RELEASE BRAKES. DELAY OF OPERATION.	NO EFFECT.	3

Table 22 (Page 16 of 32). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
		N.O. CONTACTS CLOSE TO ENERGIZE BRAKE RELAYS, 1BR AND 1BR1, WHEN THE MASTER CONTROLLER IS MOVED.	a. N.O. CONTACT FAILS OPEN a. N.O. CONTACT FAILS CLOSED b. WELDED CONTACTS, BINDING MECHANISM c. 09FY12-006.016 d. BRAKE SET LIGHT WILL NOT COME ON e. PRESS THE E-STOP BUTTON OR THE FOOT SWITCH S2. f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	UNABLE TO ENERGIZE BRAKE RELAY AND RELEASE BRAKES. DELAY OF OPERATION. BRAKE RELAYS WILL REMAIN ENERGIZED. BRAKES WILL NOT SET WHEN THE HOIST MOTORS ARE COMMANDED, VIA THE MASTER CONTROL SWITCH TO STOP. LOAD WILL DESCEND, WITH REGENERATIVE BRAKING APPLIED.	NO EFFECT. POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	3 2
		N.O. CONTACT CLOSURES TO PROVIDE A REDUNDANT POWER PATH, THROUGH SERIES ARRANGED CONTACT 1HS, TO RELEASE THE BRAKES IN THE HIGH SPEED MODE.	a. N.O. CONTACT FAILS OPEN a. N.O. CONTACT FAILS CLOSED	BRAKES WILL BE RELEASED THROUGH THE REDUNDANT 1XR CONTACT IN HIGH SPEED OPERATIONS. SERIES ARRANGED CONTACT 1HS WILL OPEN TO REMOVE POWER FROM THE BRAKE RELAYS.	NO EFFECT. NO EFFECT.	3 3

Table 22 (Page 17 of 32). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1FW	RELAY	THE RELAY ENERGIZES WHEN POWER IS APPLIED TO THE CRANE, CLOSING THE THREE NORMALLY OPEN (N.O.) CONTACTS. THE TWO SERIES ARRANGED CONTACTS BYPASS RESISTOR 1FWR TO ALLOW AN INCREASE IN CURRENT TO THE DC MOTOR FIELD WINDINGS TO STRENGTHEN THE FIELD. THE THIRD ENABLES, BUT DOES NOT ENERGIZE RELAY 1SRX. THE RELAY IS DEENERGIZED WHILE IN THE HIGH SPEED MODE, WHICH OPENS THE CONTACTS, TO PLACE RESISTORS 1FWR AND RESA IN SERIES WITH THE FIELD WINDINGS TO REDUCE THE CURRENT AND WEAKEN THE FIELD.	a. COIL FAILS OPEN b. CORROSION, FATIGUE c. 09FY12-006.099 d. SELSYN POSITION INDICATOR e. PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	THE N.O. CONTACTS WILL BE OPENED PLACING RESISTORS 1FWR AND RESA IN SERIES WITH THE DC MOTOR FIELD WINDINGS. THE FIELD WILL BE WEAKENED BY THE REDUCTION OF CURRENT THROUGH THE WINDINGS. THE HOIST WILL BE IN THE HIGH SPEED MODE CONFIGURATION. THE HOIST SPEED WILL INCREASE TO APPROXIMATELY THREE TIMES THE COMMANDED SPEED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. N.O. CONTACT FAILS OPEN (1 OF 3) b. CORROSION, BINDING MECHANISM c. 09FY12-006.100 d. SELSYN POSITION INDICATOR e. PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	THE N.O. CONTACTS (1 OF 3) WILL BE OPENED PLACING RESISTOR 1FWR OR RESA IN SERIES WITH THE DC MOTOR FIELD WINDINGS. THE FIELD WILL BE WEAKENED BY THE REDUCTION OF CURRENT THROUGH THE WINDINGS. THE HOIST WILL DESCEND AT A HIGHER RATE OF SPEED THAN EXPECTED. THE HOIST SPEED WILL INCREASE TO APPROXIMATELY TWO TIMES THE COMMANDED SPEED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2

Table 22 (Page 18 of 32). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1BR	RELAY, BRAKE	ENERGIZES TO PROVIDE POWER TO THE BRAKE SOLENOIDS TO RELEASE THE BRAKES. ALSO PROVIDES POWER TO START THE CABLE REEL TORQUE MOTOR.	a. COIL FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. BRAKES WILL NOT RELEASE. DELAY OF OPERATION.	NO EFFECT.	3
		TWO N.O. CONTACTS, ARRANGED IN SERIES WITH RELAY CONTACTS 1BR1 & 1BR2, CLOSE TO RELEASE THE BRAKES.	a. N.O. CONTACT FAILS OPEN	BRAKES WILL NOT RELEASE. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	REDUNDANT CONTACTS IN SERIES WILL OPEN TO SET THE BRAKES.	NO EFFECT.	3
		N.O. CONTACT CLOSURES TO ENERGIZE RELAY 6CR WHICH CONTROLS POWER TO RELEASE THE BRAKE ON, AND RUN THE CABLE REEL TORQUE MOTOR.	a. N.O. CONTACT FAILS OPEN	THE CABLE REEL WILL NOT START AND THE BRAKE WILL NOT RELEASE WHEN THE HOIST IS STARTED. THE CABLE WILL PULL THROUGH THE BRAKE RESISTANCE WHILE THE HOOK IS LOWERING, BUT WOULD NOT RETRACT WHILE THE HOOK IS RAISING. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	CABLE REEL MOTOR WILL CONTINUE TO RUN AND THE BRAKES WILL BE RELEASED. NO EFFECT ON THE HOIST OPERATION.	NO EFFECT.	3
		N.C. CONTACT OPENS TO EXTINGUISH THE "BRAKE SET" LIGHT INDICATOR, PL35, WHEN THE BRAKES ARE RELEASED.	a. N.C. CONTACT FAILS CLOSED	REDUNDANT CONTACT OF RELAY 1BR1 WILL OPEN TO SHUT OFF THE BRAKE SET LIGHT.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	BRAKE SET LIGHT WILL NOT COME ON WHEN BRAKES ARE SET. INDICATION PROBLEM ONLY. DELAY OF OPERATIONS.	NO EFFECT.	3

Table 22 (Page 19 of 32). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1BR1	RELAY	ENERGIZES TO PROVIDE POWER TO THE BRAKE SOLENOIDS TO RELEASE THE BRAKES.	a. COIL FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. BRAKES WILL NOT RELEASE. DELAY OF OPERATION.	NO EFFECT.	3
		TWO N.O. CONTACTS, ARRANGED IN SERIES WITH RELAY CONTACTS 1BR & 1BR2, CLOSE TO RELEASE THE BRAKES.	a. N.O. CONTACT FAILS OPEN	BRAKES WILL NOT RELEASE. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	REDUNDANT CONTACTS IN SERIES WILL OPEN TO SET THE BRAKES.	NO EFFECT.	3
		N.C. CONTACT OPENS TO EXTINGUISH THE "BRAKE SET" LIGHT INDICATOR, PL35, WHEN THE BRAKES ARE RELEASED.	a. N.C. CONTACT FAILS CLOSED	REDUNDANT CONTACT OF RELAY 1BR WILL OPEN TO SHUT OFF THE BRAKE SET LIGHT.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	BRAKE SET LIGHT WILL NOT COME ON WHEN BRAKES ARE SET. INDICATION PROBLEM ONLY. DELAY OF OPERATIONS.	NO EFFECT.	3
1BTR	RELAY	ENERGIZES TO PROVIDE POWER TO RELAY 1BRX TO REDUCE THE CURRENT TO THE BRAKE SOLENOIDS AFTER SOLENOIDS ARE ENERGIZED.	a. COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. RELAY 1BRX WILL NOT BE ENERGIZED CAUSING POSSIBLE DAMAGE TO THE BRAKE SOLENOIDS OR TRIPPING OF BREAKER 1CCB3. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	RELAY 1BRX WILL NOT BE ENERGIZED CAUSING POSSIBLE DAMAGE TO THE BRAKE SOLENOIDS OR TRIPPING OF BREAKER 1CCB3. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3

Table 22 (Page 20 of 32). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
S2	FOOT SWITCH	SWITCH CONTACT LOCATED BETWEEN RPOT AND THE GENERATOR FIELD DC INPUT CONTROLLER. THIS IS ARRANGED TO DISABLE THE RPOT INPUT WHEN OPER- ATING IN THE FLOAT MODE.	a. N.O. CONTACT FAILS CLOSED	RELAY 1BRX WILL REMAIN ENERGIZED AND THE N.C CONTACT WILL REMAIN OPEN. BRAKE SOLENOIDS MAY NOT RECEIVE ENOUGH POWER TO RELEASE THE BRAKES. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN b. CORROSION, MECHAN- ICAL FAILURE c. 09FY12-006.023 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. RETURN THE MASTER CONTROLLER TO NEUTRAL OR PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	NO RPOT GENERATOR FIELD DC INPUT CONTROLLER EXCITATION VOLTAGE AND RESULTING OUTPUT TO GENER- ATOR FIELD WINDING. NO OUTPUT FROM GENERATOR. NO HOIST MOTOR TORQUE WHILE THE COMMAND IS BEING GIVEN, VIA THE MASTER CONTROL SWITCH, TO RAISE OR LOWER AND THE BRAKES ARE RELEASED. LOAD WILL DESCEND WITH REGENERATIVE BRAKING APPLIED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. N.O. CONTACT FAILS CLOSED	RPOT WILL REMAIN ENABLED. THIS HAS NO EFFECT ON THE FLOAT MODE OF OPERATION UNLESS THE MASTER CONTROLLER IS NOT RETURNED TO NEUTRAL. OPERATOR ERROR REQUIRED.	NO EFFECT.	3

Table 22 (Page 21 of 32). **ELECTRICAL FMEA - MAIN HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
		SWITCH CONTACT CLOSES TO ENERGIZE THE FLOAT RELAY, FLT, WHICH IS USED TO DISABLE THE TIME DELAY RELAY, 1TDHC, TO INSURE THE OVERVOLTAGE RELAY, 1FOV, IS NOT BYPASSED WHEN THE FLOAT MODE IS SELECTED WHILE THE SPEED SELECTOR SWITCH, SS2, IS IN THE COARSE SPEED POSITION.	a. N.O. CONTACT FAILS OPEN	LOSS OF ABILITY TO DISABLE THE TIME DELAY RELAY WHEN OPERATING IN THE FLOAT MODE. THIS WOULD ALLOW THE TIME DELAY RELAY TO BYPASS THE OVERVOLTAGE RELAY IF THE FLOAT MODE IS SELECTED WHILE THE SPEED SELECTOR SWITCH IS IN THE COARSE SPEED POSITION. MULTIPLE FAILURE REQUIRED TO RESULT IN DAMAGE TO A VEHICLE SYSTEM.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	THE FLOAT RELAY WILL REMAIN ENERGIZED AND THE OVERVOLTAGE RELAY WOULD NOT BE BYPASSED IN THE COARSE SPEED MODE. IF THE HOIST IS OPERATED IN COARSE SPEED, THE M-G SET WILL BE SHUT DOWN BY THE OVERVOLTAGE RELAY AT 115% OF THE FULL FINE OUTPUT.	NO EFFECT.	3
		CONTACT CLOSES TO ENERGIZE RELAY 1HCR TO OPERATE THE CRANE IN THE FLOAT MODE.	a. N.O. CONTACT FAILS OPEN	UNABLE TO USE FLOAT CONTROLS FOR FLOATING THE LOAD. DELAY OF OPERATION.	NO EFFECT.	3

Table 22 (Page 22 of 32). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 Sheet No. 12/13/14/15/17/28 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
		CONTACT OPENS TO ENABLE THE OPERATOR TO CONTROL THE BRAKES WITH BRAKE SWITCH S1 FOR FLOAT MODE OPERATIONS.	a. N.O. CONTACT FAILS CLOSED b. CORROSION, WELDED CONTACT, MECHANICAL FAILURE c. 09FY12-006.096 d. INDICATION OF MOVEMENT ON THE CONSOLE SELSYN e. PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	RELAY 1HCR WILL REMAIN ENERGIZED. THIS WILL ENERGIZE THE BRAKE RELAYS, 1BR & 1BR1, AND RELEASE THE BRAKES WHILE NO COMMAND IS BEING INITIATED TO MOVE THE LOAD. LOAD WILL DESCEND WITH REGENERATIVE BRAKING APPLIED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. N.C. CONTACT FAILS OPEN	THE BRAKES CANNOT BE RELEASED WITH THE NORMAL MOVEMENT OF THE MASTER CONTROLLER, 1MC. THE BRAKES WILL REMAIN SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED b. CORROSION, WELDED CONTACT, MECHANICAL FAILURE c. 09FY12-006.097 d. INDICATION OF MOVEMENT ON THE CONSOLE SELSYN e. DISENGAGE FOOT SWITCH S2 OR PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	THE BRAKES WILL BE RELEASED WHEN THE FOOT SWITCH IS ENGAGED. LOAD WILL DESCEND WITH REGENERATIVE BRAKING APPLIED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2

Table 22 (Page 23 of 32). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
S1	BRAKE SWITCH	PROVIDES OPERATOR CONTROL OF POWER TO BRAKE RELAYS, 1BR AND 1BR1, TO RELEASE OR SET THE BRAKES WHEN REQUIRED DURING FLOAT OPERATIONS.	a. N.O. CONTACT FAILS OPEN	UNABLE TO RELEASE BRAKES FOR FLOATING OPERATIONS. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	BRAKE RELAYS WILL REMAIN ENER- GIZED AND BRAKES WILL NOT SET WHEN OPERATOR RELEASES BRAKE HANDLE DURING FLOAT OPERATIONS. THE LOAD WILL STILL BE CON- TROLLED WITH THE FLOAT POTENTIOMETER, AND THE BRAKES CAN BE SET BY RELEASING FOOT SWITCH S2. DELAY OF OPERATION.	NO EFFECT.	3
3RECT	RECTIFIER, BRIDGE	CONVERTS 120V AC INPUT TO DC OUTPUT FOR ENERGIZING RELAY 1RUN FOR CONTROL- LING CURRENT TO THE GEN- ERATOR FIELD WINDING.	a. DIODE FAILS OPEN	NO DC OUTPUT FROM 3RECT WILL DEENERGIZE DC RELAY 3DC, WHICH WILL SHUT DOWN THE M-G SET. BRAKES WILL SET. DELAY OF OPER- ATIONS.	NO EFFECT.	3
			a. DIODE FAILS SHORT	INCREASED CURRENT TO THE RELAY COILS RESULTING IN THE COILS FAILING OPEN. RELAY 3DC COIL FAILING OPEN SHUTS DOWN THE M-G SET AND SETS THE BRAKES. 1RUN COIL FAILING OPEN RESULTS IN THE N.O. CONTACT DROPPING OUT (OPEN) BY GRAVITY AND/OR THE SPRING FORCE. DELAY OF OPERATION.	NO EFFECT.	3
3DC	RELAY	ENERGIZES TO INSURE THE BRIDGE RECTIFIER, 3RECT, IS SUPPLYING THE PROPER OUTPUT. THIS WILL SHUT DOWN THE M-G SET IF 3RECT OUTPUT IS LOST.	a. COIL FAILS OPEN	RELAY CONTACTS WILL REMAIN IN THE DEENERGIZED POSITION. M-G SET CANNOT BE STARTED. DELAY OF OPERATIONS.	NO EFFECT.	3

Table 22 (Page 24 of 32). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 Sheet No. 12/13/14/15/17/28 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1RUN	RELAY	N.O. CONTACT CLOSURES TO ALLOW INPUT CURRENT FROM THE GENERATOR FIELD DC INPUT CONTROLLER TO THE M-G SET GENERATOR FIELD WINDING TO MOVE THE DC DRIVE MOTORS. N.C. CONTACT ALLOWS RESI- DUAL CURRENT IN THE GEN- ERATOR TO DIMINISH AFTER THE DRIVE MOTION IS COM- PLETED.	a. N.O. CONTACT FAILS OPEN	M-G SET CANNOT BE STARTED. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	LOSS OF M-G SET SHUT DOWN CAPA- BILITY IF 3RECT OUTPUT IS LOST. MULTIPLE FAILURE REQUIRED.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	INDICATION OF THE LOSS OF 3RECT OUTPUT WILL NOT COME ON. INDI- CATION PROBLEM ONLY.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	INDICATION OF THE LOSS OF 3RECT OUTPUT WILL REMAIN ON CONTIN- UOUSLY. INDICATION PROBLEM ONLY. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. "PULL IN" COIL FAILS OPEN b. CORROSION, FATIGUE c. 09FY12-006.018 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. RETURN THE MASTER CONTROLLER TO NEUTRAL OR PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	N.O. CONTACT REMAINS IN DE-ENERGIZED POSITION. GENER- ATOR FIELD WINDING WILL NOT BE ENERGIZED. NO HOIST MOTOR TORQUE. LOAD WILL DESCEND, WITH REGENERATIVE BRAKING APPLIED, WHEN THE COMMAND IS GIVEN, VIA THE MASTER CONTROL SWITCH, TO RAISE OR LOWER AND THE BRAKES ARE RELEASED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. "DROP OUT" COIL FAILS OPEN.	THE N.O. CONTACT WILL DROP OUT (OPEN) BY GRAVITY AND/OR THE SPRING FORCE.	NO EFFECT.	3

Table 22 (Page 25 of 32). **ELECTRICAL FMEA - MAIN HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1RS14	RESISTOR	PROVIDES A CURRENT LIMITER FOR THE RESIDUAL CURRENT IN THE GENERATOR AFTER THE DRIVE MOTION IS COMPLETED.	a. N.O. CONTACT FAILS OPEN/N.C. CONTACT FAILS CLOSED b. CORROSION, BINDING MECHANISM c. 09FY12-006.019 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. RETURN THE MASTER CONTROLLER TO NEUTRAL OR PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	GENERATOR FIELD WINDING WILL NOT BE ENERGIZED. NO HOIST MOTOR TORQUE. LOAD WILL DESCEND, WITH REGENERATIVE BRAKING APPLIED, WHEN THE COMMAND, VIA THE MASTER CONTROL SWITCH, IS GIVEN TO RAISE OR LOWER AND THE BRAKES ARE RELEASED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. N.O. CONTACT FAILS CLOSED/N.C. CONTACT FAILS OPEN	N.O. CONTACT WILL REMAIN CLOSED WHEN THE JOYSTICK IS RETURNED TO CENTER. THERE WILL BE NO INPUT TO THE GENERATOR FIELD WINDING BECAUSE THE GENERATOR FIELD DC INPUT CONTROLLER WILL BE DISA- BLED.	NO EFFECT.	3
			a. FAILS OPEN	THE RESIDUAL CURRENT IN THE GEN- ERATOR WILL NOT BE DIMINISHED. NO EFFECT ON NORMAL OPERATIONS.	NO EFFECT.	3
			a. COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. OVERHEATING ALARM WILL NOT SOUND. NO EFFECT ON INDICATOR LIGHT.	NO EFFECT.	3
1ACR	RELAY	PROVIDES POWER TO ACTI- VATE MOTOR OVERHEATING ALARM.	a. N.O. CONTACT FAILS OPEN	OVERHEATING ALARM WILL NOT SOUND. NO EFFECT ON INDICATOR LIGHT.	NO EFFECT.	3

Table 22 (Page 26 of 32). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
AL1	ALARM, MOTOR OVER- HEATING	PROVIDES AUDIBLE WARNING TO OPERATOR THAT A MOTOR IS OVERHEATING ON ONE OF THE FOUR DRIVE SYSTEMS.	a. N.O. CONTACT FAILS CLOSED a. FAILS TO OPERATE	OVERHEATING ALARM WILL SOUND INADVERTENTLY. DELAY OF OPERA- TION. OPERATOR WILL HAVE NO AUDIBLE WARNING FOR MOTOR OVERHEAT. LIGHT WILL COME ON TO WARN OPER- ATOR WHEN A MOTOR OVERHEATS. THE M-G SET WILL SHUT DOWN AUTO- MATICALLY IF MOTOR REACHES A TEMPERATURE LIMIT.	NO EFFECT. NO EFFECT.	3 3
PL8	INDICATION LAMP	PROVIDES INDICATION THAT HOIST MOTOR #1 IS OVER- HEATING.	a. FAILS OPEN	NO INDICATION FOR MOTOR OVER- HEATING FROM LIGHT. ALARM WILL SOUND.	NO EFFECT.	3
PL9	INDICATION LAMP	PROVIDES INDICATION THAT HOIST MOTOR #2 IS OVER- HEATING.	a. FAILS OPEN	NO INDICATION FOR MOTOR OVER- HEATING FROM LIGHT. ALARM WILL SOUND.	NO EFFECT.	3
PL10	INDICATION LAMP	PROVIDES INDICATION THAT HOIST BLOWER MOTOR #1 IS OVERHEATING.	a. FAILS OPEN	NO INDICATION FOR BLOWER MOTOR OVERHEATING FROM LIGHT.	NO EFFECT.	3
PL11	INDICATION LAMP	PROVIDES INDICATION THAT HOIST BLOWER MOTOR #2 IS OVERHEATING.	a. FAILS OPEN	NO INDICATION FOR BLOWER MOTOR OVERHEATING FROM LIGHT.	NO EFFECT.	3
1-OLR1, 1-OLR2	RELAY	RELAYS ENERGIZE TO ENABLE THE BLOWER MOTOR START RELAY 1MB. PRO- VIDES CAPABILITY TO SHUT DOWN BOTH BLOWER MOTORS AND LIGHT BLOWER MOTOR OVERHEATING INDIC- ATOR LIGHTS WHEN DEEN- ERGIZED BY ONE OF THE BLOWER MOTOR OVERLOADS.	a. COIL FAILS OPEN	CONTACTS REMAIN IN DEENERGIZED POSITION. THE BLOWER MOTORS WILL NOT START. BLOWER MOTOR OVERHEATING INDICATION LIGHT WILL REMAIN ON. DELAY OF OPERA- TION.	NO EFFECT	3

Table 22 (Page 27 of 32). **ELECTRICAL FMEA - MAIN HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
D1	DIODE	PREVENTS HOIST MOTOR #1 OVERHEATING INDICATOR FROM COMING ON WHILE ALARM RELAY, 1ACR, IS ENERGIZED WHEN HOIST MOTOR #2 OVERHEATS.	a. N.C. CONTACT FAILS CLOSED	BLOWER MOTOR OVERHEATING INDI- CATION LIGHT WILL REMAIN ON. DELAY OF OPERATION.	NO EFFECT	3
			a. N.C. CONTACT FAILS OPEN	BLOWER MOTOR OVERHEATING INDI- CATION LIGHT WILL NOT COME ON IF AN OVERHEAT OCCURS. THE BLOWER MOTOR WILL BE SHUT DOWN BY THE N.O. CONTACT. THE HOIST MOTOR WINDING TEMPERATURE SENSOR WILL SHUT DOWN THE HOIST M-G SET IF NECESSARY.	NO EFFECT	3
			a. N.O. CONTACT FAILS OPEN	THE BLOWER MOTORS WILL NOT START. POSSIBLE DAMAGE TO THE DC DRIVE MOTORS. THE HOIST MOTOR WINDING TEMPERATURE SENSOR WILL SHUT DOWN THE HOIST M-G SET IF NECESSARY.	NO EFFECT	3
			a. N.O. CONTACT FAILS CLOSED	SERIES ARRANGED CONTACTS WILL OPEN TO SHUT DOWN THE BLOWER MOTORS.	NO EFFECT	3
			a. FAILS OPEN	ALARM WILL NOT SOUND WHEN MOTOR #1 OVERHEATS. INDICATION LIGHT WILL SIGNAL OPERATOR OF OVERHEAT CONDITION.	NO EFFECT.	3
			a. FAILS SHORT	HOIST MOTOR #1 OVERHEAT INDI- CATOR WILL COME ON WHEN MOTOR #2 OVERHEATS. ALARM MAY NOT SOUND.	NO EFFECT.	3

Table 22 (Page 28 of 32). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
D2	DIODE	PREVENTS HOIST MOTOR #2 OVERHEATING INDICATOR FROM COMING ON WHILE ALARM RELAY, 1ACR, IS ENERGIZED WHEN HOIST MOTOR #1 OVERHEATS.	a. FAILS OPEN	ALARM WILL NOT SOUND WHEN MOTOR #2 OVERHEATS. INDICATION LIGHT WILL SIGNAL OPERATOR OF OVERHEAT CONDITION.	NO EFFECT.	3
			a. FAILS SHORT	HOIST MOTOR #2 OVERHEAT INDICATOR WILL COME ON WHEN MOTOR #1 OVERHEATS. ALARM MAY NOT SOUND.	NO EFFECT.	3
1K1	RELAY	OVERHEATING TEMPERATURE SENSING RELAY IS ACTUATED WHEN A THERMISTOR IN THE WINDINGS OF THE HOIST MOTOR #1 REACHES A PREDETERMINED TEMPERATURE. THE CONTACTS CLOSE TO SOUND ALARM AND TURN ON OVERHEATING INDICATOR LIGHT.	a. THERMISTOR COIL FAILS OPEN	LOSS OF MOTOR OVERHEATING DETECTION CIRCUIT. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 1K3 TO SHUT DOWN M-G SET IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3
			a. THERMISTOR COIL FAILS SHORT	RELAY MAY BE ENERGIZED CAUSING ALARM TO SOUND AND OVERHEATING INDICATOR LIGHT TO COME ON. DELAY OF OPERATION.	NO EFFECT.	3
			a. RELAY COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. ALARM WILL NOT SOUND AND OVERHEATING INDICATOR LIGHT WILL NOT LIGHT. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 1K3 TO SHUT DOWN M-G SET IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3

Table 22 (Page 29 of 32). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1K2	RELAY	OVERHEATING TEMPERATURE SENSING RELAY IS ACTUATED WHEN A THERMISTOR IN THE WINDINGS OF HOIST MOTOR #2 REACHES A PRE-DETERMINED TEMPERATURE. THE CONTACTS CLOSE TO SOUND ALARM AND TURN ON OVERHEATING INDICATOR LIGHT.	a. N.O. CONTACT FAILS OPEN	ALARM WILL NOT SOUND AND OVERHEATING INDICATOR LIGHT WILL NOT LIGHT IF A MOTOR OVERHEAT OCCURS. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 1K3 TO SHUT DOWN M-G SET IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	OVERHEAT ALARM AND LIGHT WILL BE ON. DELAY OF OPERATION.	NO EFFECT.	3
			a. THERMISTOR COIL FAILS OPEN	LOSS OF MOTOR OVERHEATING DETECTION CIRCUIT. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 1K4 TO SHUT DOWN M-G SET IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3
			a. THERMISTOR COIL FAILS SHORT	RELAY MAY BE ENERGIZED CAUSING ALARM TO SOUND AND OVERHEATING INDICATOR LIGHT TO COME ON. DELAY OF OPERATION.	NO EFFECT.	3
			a. RELAY COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. ALARM WILL NOT SOUND AND OVERHEATING INDICATOR LIGHT WILL NOT LIGHT. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 1K4 TO SHUT DOWN M-G SET IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3

Table 22 (Page 30 of 32). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1K3	RELAY	OVERHEATING TEMPERATURE SENSING RELAY IS ACTUATED WHEN A THERMISTOR IN THE WINDINGS OF HOIST MOTOR #1 REACHES A PRE-DETERMINED TEMPERATURE. THE CONTACTS OPEN TO SHUT DOWN THE M-G SET.	a. N.O. CONTACT FAILS OPEN	ALARM WILL NOT SOUND AND OVERHEATING INDICATOR LIGHT WILL NOT LIGHT IF A MOTOR OVERHEAT OCCURS. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 1K4 TO SHUT DOWN M-G SET IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	OVERHEAT ALARM AND LIGHT WILL BE ON. DELAY OF OPERATION.	NO EFFECT.	3
			a. THERMISTOR COIL FAILS OPEN	LOSS OF MOTOR OVERHEATING DETECTION CIRCUIT. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 1K1 TO SOUND ALARM AND LIGHT OVERHEATING INDICATOR LIGHT IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3
			a. THERMISTOR COIL FAILS SHORT	RELAY MAY BE ENERGIZED CAUSING M-G SET TO SHUT DOWN. DELAY OF OPERATION.	NO EFFECT.	3
			a. RELAY COIL FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 1K1 TO SOUND ALARM AND LIGHT OVERHEATING INDICATOR LIGHT IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	M-G SET WILL NOT SHUT DOWN IF A MOTOR OVERHEAT OCCURS. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 1K1 TO SOUND ALARM AND LIGHT OVERHEATING INDICATOR LIGHT IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3

Table 22 (Page 31 of 32). **ELECTRICAL FMEA - MAIN HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1K4	RELAY	OVERHEATING TEMPERATURE SENSING RELAY IS ACTUATED WHEN A THERMISTOR IN THE WINDINGS OF HOIST MOTOR #2 REACHES A PRE-DETERMINED TEMPERATURE. THE CONTACTS OPEN TO SHUT DOWN THE M-G SET.	a. N.C. CONTACT FAILS OPEN	M-G SET WILL NOT START. DELAY OF OPERATION.	NO EFFECT.	3
			a. THERMISTOR COIL FAILS OPEN	LOSS OF MOTOR OVERHEATING DETECTION CIRCUIT. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 1K2 TO SOUND ALARM AND LIGHT OVERHEATING INDICATOR LIGHT IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3
			a. THERMISTOR COIL FAILS SHORT	RELAY MAY BE ENERGIZED CAUSING M-G SET TO SHUT DOWN. DELAY OF OPERATION.	NO EFFECT.	3
			a. RELAY COIL FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 1K2 TO SOUND ALARM AND LIGHT OVERHEATING INDICATOR LIGHT IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	M-G SET WILL NOT SHUT DOWN IF A MOTOR OVERHEAT OCCURS. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 1K2 TO SOUND ALARM AND LIGHT OVERHEATING INDICATOR LIGHT IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3
1F3	FUSE	PROTECTS FAN MOTORS, M31 & M32, FROM CURRENT OVER-LOAD.	a. N.C. CONTACT FAILS OPEN a. PREMATURE ACTUATION	M-G SET WILL NOT START. DELAY OF OPERATION. FAN MOTORS, M31 & M32, WILL STOP. LOSS OF AIRFLOW IN THE RELAY CABINET. NO EFFECT ON CRANE OPERATION.	NO EFFECT. NO EFFECT.	3 3

Table 22 (Page 32 of 32). **ELECTRICAL FMEA - MAIN HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
M31, M32	FAN MOTORS	PROVIDES COOLING FOR THE DRIVE CONTROL RELAY CABINET.	a. FAILS TO ACTUATE	POSSIBLE DAMAGE TO THE FAN MOTORS, M31 & M32. MULTIPLE FAILURE REQUIRED.	NO EFFECT.	3
			a. FAILS TO OPERATE	LOSS OF AIRFLOW IN THE RELAY CABINET. NO EFFECT ON CRANE OPERATION.	NO EFFECT.	3

Table 23 (Page 1 of 5). **ELECTRICAL FMEA - MAIN HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 11, 13 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
RPOT	POTENTIO- METER	REFERENCE POTENTIOMETER CONNECTED TO THE MASTER CONTROL SWITCH (JOYSTICK), IMC, TO REGU- LATE THE INPUT EXCITATION VOLTAGE TO THE GENER- ATOR FIELD DC INPUT CON- TROLLER, IFC, AND THE RESULTING OUTPUT TO THE GENERATOR FIELD WINDING FOR HOIST SPEED CONTROL DURING RAISING OR LOW- ERING OPERATIONS.	a. FAIL OPEN b. CORROSION, FATIGUE c. 09FY12-006.022 d. CURRENT INDICATION ON CONSOLE AMMETER e. BRING THE MASTER CONTROLLER TO NEUTRAL OR PRESS E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	IF THE FAILURE OCCURS ON THE WIPER ARM IT WOULD RESULT IN NO GENERATOR FIELD DC INPUT CON- TROLLER EXCITATION VOLTAGE. NO GENERATOR FIELD WINDING VOLTAGE. NO OUTPUT FROM GENERATOR. NO HOIST MOTOR TORQUE WHILE THE COMMAND IS BEING GIVEN, VIA THE MASTER CONTROL SWITCH, TO RAISE OR LOWER AND THE BRAKES ARE RELEASED. LOAD WILL DESCEND WITH REGENERATIVE BRAKING APPLIED. OR IF THE FAILURE OCCURS ON THE RESISTIVE ELEMENT, IT WOULD RESULT IN A LOSS OF THE PARALLEL RESISTANCE BRANCH AND CREATE A LARGER INPUT INTO THE GENERATOR FIELD DC INPUT CONTROLLER WHICH WILL CAUSE AN INCREASING SPEED OF THE DC MOTORS CONTROLLING THE HOIST.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
1RR4A, 1RR4B	RESISTOR	PROVIDES A VOLTAGE DIVIDER FOR THE +/- 6VDC POWER SOURCE TO RPOT, FOR INPUT TO THE GENER- ATOR FIELD DC INPUT CON- TROLLER, IFC, TO ALLOW FOR HOIST OPERATION IN THE FINE SPEED MODE.	a. FAILS OPEN b. CONTAMINATION, COR- ROSION, FATIGUE c. 09FY12-006.065 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. BRING THE MASTER CONTROLLER TO NEUTRAL OR PRESS E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	NO GENERATOR FIELD DC INPUT CON- TROLLER EXCITATION VOLTAGE IN THE FINE SPEED MODE OF OPERA- TION. NO GENERATOR FIELD WINDING VOLTAGE. NO OUTPUT FROM GENER- ATOR. NO HOIST MOTOR TORQUE WHILE THE COMMAND IS BEING GIVEN, VIA THE MASTER CONTROL SWITCH, TO RAISE OR LOWER THE LOAD WHILE THE BRAKES ARE RELEASED. LOAD WILL DESCEND WITH REGENERATIVE BRAKING APPLIED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2

Table 23 (Page 2 of 5). **ELECTRICAL FMEA - MAIN HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 11, 13 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
FPOT	POTENTIO- METER	CONTROLS THE INPUT EXCITATION VOLTAGE TO THE GENERATOR FIELD DC INPUT CONTROLLER, 1FC, AND THE RESULTING OUTPUT TO GEN- ERATOR FIELD WINDING FOR HOIST CONTROL DURING FLOAT OPERATIONS.	a. FAIL OPEN b. CORROSION, FATIGUE c. 09FY12-006.025 d. CURRENT INDICATION ON CONSOLE AMMETER e. RELEASE BRAKE SWITCH f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	NO GENERATOR FIELD DC INPUT CON- TROLLER EXCITATION VOLTAGE WHILE IN THE FLOAT MODE. NO GENERATOR FIELD WINDING VOLTAGE. NO OUTPUT FROM GENERATOR NO HOIST MOTOR TORQUE WHILE THE COMMAND IS BEING GIVEN TO FLOAT AND THE BRAKES ARE RELEASED, VIA THE BRAKE SWITCH. LOAD WILL DESCEND WITH REGENERATIVE BRAKING APPLIED. OR IF THE FAILURE OCCURS ON THE RESISTIVE ELEMENT, IT WOULD RESULT IN A LOSS OF THE PARALLEL RESISTANCE BRANCH AND CREATE A LARGER INPUT INTO THE GENERATOR FIELD DC INPUT CONTROLLER WHICH WILL CAUSE AN INCREASED INPUT TO THE DC MOTORS CONTROLLING THE HOIST. THIS COULD RESULT IN AN INADVERTENT MOVEMENT OF THE LOAD.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
1RR7	RESISTOR	PROVIDES A VOLTAGE DIVIDER FOR THE INPUT FROM FPOT TO THE GENER- ATOR FIELD DC INPUT CON- TROLLER, 1FC, TO ALLOW FOR HOIST OPERATION IN THE FLOAT MODE.	a. FAILS OPEN b. CONTAMINATION, COR- ROSION, FATIGUE c. 09FY12-006.066 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. RELEASE BRAKE SWITCH f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	NO GENERATOR FIELD DC INPUT CON- TROLLER EXCITATION VOLTAGE IN THE FLOAT MODE OF OPERATION. NO GENERATOR FIELD WINDING VOLTAGE. NO OUTPUT FROM GENERATOR. NO HOIST MOTOR TORQUE WHILE THE COMMAND IS BEING GIVEN TO FLOAT AND THE BRAKES ARE RELEASED, VIA THE BRAKE SWITCH. LOAD WILL DESCEND WITH REGENERATIVE BRAKING APPLIED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
7AM	AMMETER	PROVIDES INDICATION AT THE CONSOLE OF THE CURRENT TO THE HOIST MOTORS.	a. FAILS OPEN	LOSS OF INDICATION TO OPERATOR OF MOTOR CURRENT. DELAY OF OPERATION.	NO EFFECT.	3

Table 23 (Page 3 of 5). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 Sheet No. 15 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 11, 13 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
M1	HOIST METER RELAY	CONTROLS RELAY K10 TO SCALE CURRENT READING ON THE CONSOLE AMMETER BY A FACTOR OF 10 WHEN THE HOIST MOTORS CURRENT REACHES 60 AMPS. ALSO CONTROLS CONSOLE LIGHT PL34 TO INDICATE TO OPER- ATOR WHEN CURRENT READING IS SCALED.	a. COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. CURRENT READING ON CONSOLE AMMETER WILL NOT BE SCALED BY A FACTOR OF 10. DELAY OF OPERATION.	NO EFFECT.	3
			a. HIGH/LOW LIMIT NO. 1 N.O. CONTACT FAILS OPEN	PL34 WILL NOT LIGHT WHEN CURRENT TO HOIST MOTORS REACHES 60 AMPS TO INDICATE TO OPERATOR THAT THE CONSOLE AMMETER READING IS NOW SCALED. DELAY OF OPERATION.	NO EFFECT.	3
			a. HIGH/LOW LIMIT NO. 1 N.O. CONTACT FAILS CLOSED	PL34 WILL BE LIT FOR ENTIRE RANGE OF CURRENT TO HOIST MOTORS. DELAY OF OPERATION.	NO EFFECT.	3
			a. HIGH/LOW LIMIT NO. 2 N.C. CONTACT FAILS CLOSED	RELAY K10 WILL NOT BE DEENER- GIZED TO BRING RESISTOR R1 INTO USE TO SCALE THE CURRENT READING ON THE CONSOLE AMMETER. DELAY OF OPERATION.	NO EFFECT.	3

Table 23 (Page 4 of 5). **ELECTRICAL FMEA - MAIN HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 11, 13 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
K10	RELAY	ENERGIZED WHEN HOIST MOTORS ARE DRAWING LESS THAN 60 AMPS. CONTACT IS CLOSED TO ALLOW THE CONSOLE AMMETER TO DISPLAY ACTUAL CURRENT. DE-ENERGIZED WHEN CURRENT REACHES 60 AMPS TO SCALE THE CURRENT READING ON THE CONSOLE AMMETER BY A FACTOR OF 10.	a. HIGH/LOW LIMIT NO. 2 N.C. CONTACT FAILS OPEN b. CORROSION, BINDING MECHANISM c. 09FY12-006.029 d. ABNORMAL MOVEMENT OF LOAD e. PRESS E-STOP OR RELEASE BRAKE SWITCH f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	RELAY K10 WILL NOT BE ENERGIZED AND THE CURRENT READING ON CONSOLE AMMETER WILL BE SCALED WITHOUT INDICATION FROM CONSOLE LIGHT PL34. THIS COULD LEAD TO AN OPERATOR GIVING AN ERRONEOUS INPUT DURING FLOAT OPERATIONS RESULTING IN AN INADVERTENT MOVEMENT OF THE LOAD.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. COIL FAILS OPEN b. CORROSION, FATIGUE c. 09FY12-006.030 d. ABNORMAL MOVEMENT OF LOAD e. PRESS E-STOP OR RELEASE BRAKE SWITCH f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	CONTACT REMAINS IN DE-ENERGIZED POSITION. THE CURRENT READING ON THE CONSOLE AMMETER WILL BE SCALED WITHOUT INDICATION FROM CONSOLE LIGHT PL34. THIS COULD LEAD TO AN OPERATOR GIVING AN ERRONEOUS INPUT DURING FLOAT OPERATIONS RESULTING IN AN INADVERTENT MOVEMENT OF THE LOAD.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. N.O. CONTACT FAILS OPEN b. CORROSION, BINDING MECHANISM c. 09FY12-006.031 d. ABNORMAL MOVEMENT OF LOAD e. PRESS E-STOP OR RELEASE BRAKE SWITCH f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	THE CURRENT READING ON THE CONSOLE AMMETER WILL BE SCALED WITHOUT INDICATION FROM CONSOLE LIGHT PL34. THIS COULD LEAD TO AN OPERATOR GIVING AN ERRONEOUS INPUT DURING FLOAT OPERATIONS RESULTING IN AN INADVERTENT MOVEMENT OF THE LOAD.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2

Table 23 (Page 5 of 5). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 11, 13 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
R1	RESISTOR, VARIABLE	WHEN CURRENT IN THE HOIST MOTORS REACHES 60 AMPS, THIS RESISTOR IS USED FOR CURRENT LIMITING TO TO SCALE THE CONSOLE AMMETER CURRENT READING BY A FACTOR OF 10.	a. N.O. CONTACT FAILS CLOSED a. FAILS OPEN	RESISTOR R1 WILL NOT BE BROUGHT INTO USE TO SCALE THE CURRENT READING ON THE CONSOLE AMMETER. DELAY OF OPERATION. NO CURRENT READING ON CONSOLE AMMETER FOR HIGH CURRENT OPER- ATIONS. DELAY OF OPERATION.	NO EFFECT. NO EFFECT.	3 3
PL34	INDICATOR LIGHT	LIGHTS WHEN CURRENT TO HOIST MOTORS REACHES 60 AMPS AND INDICATES TO THE OPERATOR THAT THE CONSOLE AMMETER READING IS NOW SCALED BY A FACTOR OF 10.	a. FAIL OPEN	FAILS TO INDICATE TO OPERATOR THAT THE READING ON THE CONSOLE AMMETER IS SCALED BY A FACTOR OF 10. OPERATOR WILL SEE CHANGE IN CURRENT ON THE AMMETER WHEN CURRENT REACHES 60A. DELAY OF OPERATION.	NO EFFECT.	3
1-OLA	RELAY, OVERLOAD (INSTANTA- NEOUS)	SHUTS DOWN THE HOIST M-G SET IF THE HOIST MOTORS EXPERIENCE AN OVERLOAD. (NOTE GROUND RULE e).	a. N.C. CONTACT FAILS CLOSED a. N.C. CONTACT FAILS OPEN	M-G SET WILL NOT SHUT DOWN IF AN OVERLOAD CONDITION OCCURS. POS- SIBLE DAMAGE TO THE DC DRIVE MOTORS. MULTIPLE FAILURE REQUIRED. M-G SET WILL NOT RUN. DELAY OF OPERATION.	NO EFFECT. NO EFFECT.	3 3

System 175-TON BRIDGE CRANE, VAB
Subsystem MAIN HOIST
Drawing No. 67-K-L-11348 **Sheet No.** 12/13/15
PMN K60-0528

Station Set/Facility Code TA
Date JULY 1993
Reference Figure Used 10, 12
Prepared By C. CRABB, LSOC 52-11

FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1VR	RELAY, VOLTAGE	MONITORS VOLTAGE IN THE HOIST MOTOR LOOP AND PROVIDES LATCHING TO KEEP RELAYS 1HCR OR 1LCR ENERGIZED, AFTER MASTER CONTROL SWITCH IS RETURNED TO THE NEUTRAL POSITION. THIS PREVENTS THE BRAKES FROM SETTING WHILE VOLTAGE IN THE MOTOR LOOP IS ABOVE A PREDETERMINED LIMIT.	a. COIL FAILS OPEN	CONTACT REMAINS IN DE-ENERGIZED POSITION. BRAKES WILL SET IMMEDIATELY WHEN MASTER CONTROL SWITCH IS MOVED TO STOP POSITION. POSSIBLE DAMAGE TO THE BRAKES.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	BRAKES WILL SET IMMEDIATELY WHEN MASTER CONTROL SWITCH IS MOVED TO STOP POSITION. POSSIBLE DAMAGE TO THE BRAKES.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED b. WELDED CONTACT, BINDING MECHANISM c. 09FY12-006.033 d. BRAKE SET LIGHT WILL NOT COME ON e. PRESS E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	BRAKE RELAYS WILL REMAIN ENERGIZED AND BRAKES WILL NOT SET WHEN THE HOIST MOTORS ARE COMMANDED, VIA THE MASTER CONTROL SWITCH, TO STOP. LOAD WILL DESCEND WITH REGENERATIVE BRAKING APPLIED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
1KR	RELAY	MONITORS VOLTAGE SUPPLIED TO THE MOTOR IN THE M-G SET, AND THE HOOK SWIVEL CONTROLS. THIS WILL DISABLE THE CONTROLS AND SET THE BRAKES IF THE VOLTAGE IS LOST.	a. COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. BRAKES WILL BE SET. DELAY OF OPERATION.	NO EFFECT.	3

Table 24 (Page 2 of 3). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
		N.O. CONTACT CLOSSES TO ENERGIZE RELAY 1SRX. RELAY 1SRX CONTACT CLOSSES TO BYPASS RESISTOR RESA WHICH ALLOWS AN INCREASE IN CURRENT TO THE DC MOTOR FIELD WINDINGS TO STRENGTHEN THE FIELD FOR NORMAL OPERATIONS.	a. N.O. CONTACT FAILS OPEN b. CORROSION, BINDING MECHANISM c. 09FY12-006.095 d. SELSYN POSITION INDICATOR e. PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	THE N.O. CONTACT WILL BE OPEN TO DEENERGIZE RELAY 1SRX. THIS PLACES RESISTOR RESA IN SERIES WITH THE DC MOTOR FIELD WINDINGS. THE FIELD WILL BE WEAKENED BY THE REDUCTION OF CURRENT THROUGH THE WINDINGS. THE HOIST SPEED WILL INCREASE TO APPROXIMATELY TWO TIMES THE COMMANDED SPEED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. N.O. CONTACT FAILS CLOSED	SERIES ARRANGED RELAY CONTACT 1FW WILL OPEN TO DEENERGIZE 1SRX. NO EFFECT ON NORMAL OPERATION.	NO EFFECT.	3
		N.O. CONTACT, ARRANGED IN SERIES WITH RELAY CONTACT 1KRX CLOSSES TO ENABLE THE HOIST CONTROL CIRCUITRY.	a. N.O. CONTACT FAILS OPEN	CONTROL CIRCUITRY WILL NOT BE ENABLED. BRAKES WILL BE SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	RELAY CONTACT 1KRX, ARRANGED IN SERIES, WILL OPEN TO DISABLE THE CIRCUIT.	NO EFFECT.	3
		N.O. CONTACT CLOSSES TO ENABLE FOOT SWITCH S2 FOR USE IN THE FLOAT CONTROL MODE.	a. N.O. CONTACT FAILS OPEN	FOOT SWITCH S2 WILL NOT BE ENABLED FOR THE FLOAT MODE. BRAKES WILL BE SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	FOOT SWITCH S2 WILL REMAIN ENABLED. NO EFFECT ON NORMAL OPERATION.	NO EFFECT.	3

Table 24 (Page 3 of 3). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1RF9, 1RF10	FUSE, 10A	N.O. CONTACT CLOSURES TO ENERGIZE FAN MOTORS M31 & M32 WHICH PROVIDE COOLING FOR THE DRIVE CONTROL RELAY CABINET.	a. N.O. CONTACT FAILS OPEN	FAN MOTORS WILL NOT COME ON. LOSS OF AIRFLOW IN THE RELAY CABINET. NO EFFECT ON CRANE OPERATION.	NO EFFECT.	3
		N.O. CONTACT, ARRANGED IN SERIES WITH RELAY CONTACT 1BTR CLOSURES TO ENERGIZE RELAY 1BRX, WHICH OPENS TO REDUCE THE CURRENT TO THE BRAKE SOLENOIDS AFTER THEY ARE ENERGIZED.	a. N.O. CONTACT FAILS CLOSED	FAN MOTORS WILL REMAIN ON.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	RELAY 1BRX WILL NOT BE ENERGIZED CAUSING POSSIBLE DAMAGE TO THE BRAKE SOLENOIDS OR TRIPPING OF CB 1CCB3. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	RELAY CONTACT 1BTR, ARRANGED IN SERIES, WILL OPEN TO DEENERGIZE RELAY 1BRX. NO EFFECT ON HOIST OPERATION.	NO EFFECT.	3
			a. PREMATURE ACTUATION	RELAY 1KR WILL BE DEENERGIZED WHICH WILL DISABLE THE HOIST CONTROLS. THE BRAKES WILL SET. DELAY OF OPERATIONS.	NO EFFECT.	3
		PROVIDES PROTECTION AGAINST AN OVERCURRENT CONDITION FOR 1KR RELAY COIL.	a. FAILS TO ACTUATE	1KR RELAY COIL MAY BE EXPOSED TO HIGHER THAN EXPECTED CURRENTS. POSSIBLE DAMAGE TO THE RELAY COIL. MULTIPLE FAILURE REQUIRED.	NO EFFECT.	3

Table 25 (Page 1 of 5). **ELECTRICAL FMEA - MAIN HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 Sheet No. 12 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1CCB2	CIRCUIT BREAKER, 15AT	PROVIDES OVERLOAD PRO- TECTION FOR CIRCUIT PRO- VIDING POWER TO THE HOIST DC MOTOR FIELD WINDINGS.	a. PREMATURE TRIP a. FAILS TO TRIP	LOSS OF POWER TO THE HOIST DC MOTOR FIELD WINDINGS AND FIELD LOSS RELAY. M-G SET WILL SHUT DOWN WHEN 1FLA AND/OR 1FLB DEEN- ENERGIZE. DELAY OF OPERATION. UPSTREAM BREAKER 12CB MAY TRIP CAUSING BRAKES TO SET. POSSIBLE DAMAGE TO THE MOTOR FIELD WINDINGS. DELAY OF OPERATION.	NO EFFECT. NO EFFECT.	3 3
1SRX	RELAY	PROVIDES PATH FOR FULL POWER TO THE DC MOTOR FIELD FOR NORMAL OPER- ATIONS WHEN ENERGIZED. WHEN IT IS DEENERGIZED THE DC MOTOR FIELD RECEIVES REDUCED POWER FOR HIGH SPEED OPER- ATIONS.	a. COIL FAILS OPEN b. CORROSION, FATIGUE c. 09FY12-006.101 d. SELSYN POSITION INDI- CATOR e. PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS a. N.O. CONTACT FAILS OPEN b. CORROSION, BINDING MECHANISM c. 09FY12-006.102 d. SELSYN POSITION INDI- CATOR e. PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS a. N.O. CONTACT FAILS CLOSED	THE N.O. CONTACT WILL BE OPENED PLACING RESISTOR RESA IN SERIES WITH THE DC MOTOR FIELD WINDINGS. THE FIELD WILL BE WEAK- ENED BY THE REDUCTION OF CURRENT THROUGH THE WINDINGS. THE HOIST SPEED WILL INCREASE TO APPROXIMATELY TWO TIMES THE COMMANDED SPEED. THE N.O. CONTACT WILL BE OPENED PLACING RESISTOR RESA IN SERIES WITH THE DC MOTOR FIELD WINDINGS. THE FIELD WILL BE WEAK- ENED BY THE REDUCTION OF CURRENT THROUGH THE WINDINGS. THE HOIST SPEED WILL INCREASE TO APPROXIMATELY TWO TIMES THE COMMANDED SPEED. LOSS OF ABILITY TO REDUCE THE POWER TO THE DC MOTOR FIELD FOR HIGH SPEED OPERATION.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM. POSSIBLE DAMAGE TO A VEHICLE SYSTEM. NO EFFECT.	2 2 3

Table 25 (Page 2 of 5). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1FLA	RELAY	PROVIDES PROTECTION IF POWER TO THE EAST DC MOTOR FIELD WINDING IS LOST. N.O. CONTACT WILL OPEN TO SHUT DOWN THE M-G SET.	a. COIL FAILS OPEN a. N.O. CONTACT FAILS OPEN a. N.O. CONTACT FAILS CLOSED	CONTACT WILL REMAIN IN DE-ENERGIZED POSITION. M-G SET WILL NOT RUN. DELAY OF OPERATION. M-G SET WILL NOT RUN. DELAY OF OPERATION. IF POWER IS LOST IN THE MOTOR FIELD WINDING CIRCUIT, THE CONTACT FOR RELAY 1FLB WILL OPEN TO SHUT DOWN THE M-G SET. IF ONE MOTOR FIELD WINDING OPENS, THE REMAINING OPERATIONAL MOTOR WILL HOLD LOAD.	NO EFFECT. NO EFFECT. NO EFFECT.	3 3 3
1FLB	RELAY	PROVIDES PROTECTION IF POWER TO THE WEST DC MOTOR FIELD WINDING IS LOST. N.O. CONTACT WILL OPEN TO SHUT DOWN THE M-G SET.	a. COIL FAILS OPEN a. N.O. CONTACT FAILS OPEN a. N.O. CONTACT FAILS CLOSED	CONTACT WILL REMAIN IN DE-ENERGIZED POSITION. M-G SET WILL NOT RUN. DELAY OF OPERATION. M-G SET WILL NOT RUN. DELAY OF OPERATION. IF POWER IS LOST IN THE MOTOR FIELD WINDING CIRCUIT, THE CONTACT FOR RELAY 1FLA WILL OPEN TO SHUT DOWN THE M-G SET. IF ONE MOTOR FIELD WINDING OPENS, THE REMAINING OPERATIONAL MOTOR WILL HOLD LOAD.	NO EFFECT. NO EFFECT NO EFFECT	3 3 3

Table 25 (Page 3 of 5). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
RESA	RESISTOR	PROVIDES VOLTAGE DIVIDING CAPABILITY TO REDUCE THE VOLTAGE ACROSS THE DC MOTOR FIELD WINDINGS FOR OPERATION IN THE HIGH SPEED MODE.	a. FAIL OPEN	NO POWER TO FIELD WINDINGS IN THE HIGH SPEED MODE. THE M-G SET WILL BE SHUT DOWN BY THE FIELD LOSS RELAYS. DELAY OF OPERATION.	NO EFFECT.	3
RESB	RESISTOR	PROVIDES VOLTAGE DIVIDING CAPABILITY TO REGULATE THE VOLTAGE ACROSS THE DC MOTOR FIELD WINDINGS.	a. FAILS OPEN	NO POWER TO FIELD WINDINGS. THE M-G SET WILL BE SHUT DOWN BY THE FIELD LOSS RELAYS. DELAY OF OPERATION.	NO EFFECT.	3
1RES1	RESISTOR, THYRITE	MAINTAINS PREDETERMINED VOLTAGE CEILING ACROSS THE DC MOTOR FIELD WINDINGS. THIS WILL NOT CONDUCT UNTIL IT REACHES THE BREAKDOWN VOLTAGE AT WHICH TIME IT WILL CONDUCT AND KEEP THE DC MOTOR FIELD WINDINGS AT THE PROPER VOLTAGE.	a. FAIL OPEN	THE DC MOTOR FIELD WINDINGS MAY BE EXPOSED TO HIGHER VOLTAGES THAN EXPECTED. POSSIBLE DAMAGE TO THE MOTOR FIELD WINDINGS.	NO EFFECT.	3
1FWR	RESISTOR	PROVIDES VOLTAGE DIVIDING CAPABILITY TO REDUCE THE VOLTAGE ACROSS THE DC MOTOR FIELD WINDINGS FOR OPERATION IN THE HIGH SPEED MODE.	a. FAIL OPEN	NO POWER TO FIELD WINDINGS IN THE HIGH SPEED MODE. THE M-G SET WILL BE SHUT DOWN BY THE FIELD LOSS RELAYS. DELAY OF OPERATION.	NO EFFECT.	3
1CCB3	CIRCUIT BREAKER, 30AT	PROVIDES OVERLOAD PROTECTION FOR CIRCUIT PROVIDING POWER TO THE BRAKE SOLENOIDS.	a. PREMATURE TRIP	LOSS OF POWER TO THE BRAKE SOLENOIDS. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAILS TO TRIP	UPSTREAM CIRCUIT BREAKER 12CB MAY TRIP CAUSING BRAKES TO SET. POSSIBLE DAMAGE TO THE BRAKE SOLENOIDS. DELAY OF OPERATION.	NO EFFECT.	3

Table 25 (Page 4 of 5). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 Sheet No. 12 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1BRX	RELAY	ENERGIZES TO REDUCE THE VOLTAGE DROP ON THE BRAKE SOLENOIDS AFTER THE INITIAL VOLTAGE REQUIRED TO RELEASE BRAKES HAS BEEN APPLIED.	a. COIL FAILS OPEN a. N.C. CONTACT FAILS CLOSED a. N.C. CONTACT FAILS OPEN	CONTACT REMAINS IN DE-ENERGIZED POSITION CAUSING POSSIBLE DAMAGE TO THE BRAKE SOLENOIDS OR TRIPPING OF CB 1CCB3. BRAKES WILL SET. DELAY OF OPERATION. POSSIBLE DAMAGE TO THE BRAKE SOLENOIDS OR TRIPPING OF CB 1CCB3. BRAKES WILL SET. DELAY OF OPERATION. BRAKE SOLENOIDS MAY NOT RECEIVE ENOUGH POWER TO RELEASE THE BRAKES. DELAY OF OPERATION.	NO EFFECT. NO EFFECT. NO EFFECT.	3 3 3
RESC	RESISTOR	PROVIDES VOLTAGE DIVIDING TO REDUCE THE VOLTAGE ACROSS THE BRAKE SOLENOIDS AFTER THEY ARE INITIALLY ENERGIZED.	a. FAIL OPEN	NO POWER TO BRAKE SOLENOID. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
RESD	RESISTOR	PROVIDES VOLTAGE DIVIDING TO REGULATE THE VOLTAGE ACROSS THE BRAKE SOLENOIDS.	a. FAIL OPEN	NO POWER TO BRAKE SOLENOID. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
1RES2	RESISTOR, THYRITE	MAINTAINS PREDETERMINED VOLTAGE CEILING ACROSS THE BRAKE SOLENOIDS. THIS WILL NOT CONDUCT UNTIL IT REACHES THE BREAKDOWN VOLTAGE AT WHICH TIME IT WILL CONDUCT AND KEEP THE BRAKE SOLENOIDS AT THE PROPER VOLTAGE.	a. FAIL OPEN	BRAKE SOLENOIDS MAY BE EXPOSED TO HIGHER VOLTAGES THAN EXPECTED. POSSIBLE DAMAGE TO THE SOLENOIDS.	NO EFFECT.	3

Table 25 (Page 5 of 5). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 12 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
BR	BRAKE SOLENOID (1 OF 2)	WHEN THE COIL, CON- TROLLED BY RELAYS 1BR, 1BR1, AND 1BR2, IS ENER- GIZED, BRAKES WILL RELEASE.	a. COIL FAILS OPEN	BRAKES WILL SET. DELAY OF OPERA- TION.	NO EFFECT.	3
PL35	INDICATION LAMP	PROVIDES INDICATION THAT BRAKES ARE SET.	a. FAILS OPEN	LIGHT WILL NOT COME ON TO INDI- CATE BRAKES ARE SET.	NO EFFECT.	3

Table 26 (Page 1 of 14). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 14 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1KRX	RELAY	PROVIDES PROTECTION AGAINST THE LOSS OF POWER TO THE GENERATOR FIELD DC INPUT CONTROLLER. RELAYS 1KR1, 1KR2, & 1KR3 MONITOR THIS POWER AND ENERGIZE THIS RELAY. THIS ENABLES THE HOIST CONTROLS IF THE POWER IS PRESENT AND IT DISABLES THE CONTROLS IF THE POWER IS NOT PRESENT.	a. COIL FAILS OPEN	CONTACT REMAINS IN DE-ENERGIZED POSITION. HOIST CONTROLS WILL REMAIN DISABLED. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	HOIST CONTROLS WILL REMAIN DISABLED. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	LOSS OF ABILITY TO DISABLE THE HOIST CONTROLS IF POWER IS LOST TO ONE OF THE THREE RELAYS. MULTIPLE FAILURE REQUIRED.	NO EFFECT.	3
1KR1	RELAY	MONITORS POWER SUPPLIED TO THE GENERATOR FIELD DC INPUT CONTROLLER DOWNSTREAM OF TRANSFORMER 1RT1. THE N.O. CONTACT IS ARRANGED IN SERIES WITH CONTACTS OF RELAYS 1KR2 & 1KR3 WHICH CLOSE TO ENERGIZE RELAY 1KRX.	a. COIL FAILS OPEN	CONTACT REMAINS IN DE-ENERGIZED POSITION. RELAY 1KRX WILL REMAIN DEENERGIZED. HOIST CONTROLS WILL REMAIN DISABLED. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	RELAY 1KRX WILL REMAIN DEENERGIZED. HOIST CONTROLS WILL REMAIN DISABLED. DELAY OF OPERATIONS.	NO EFFECT.	3

Table 26 (Page 2 of 14). **ELECTRICAL FMEA - MAIN HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 14 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1KR2	RELAY	MONITORS POWER SUPPLIED TO THE GENERATOR FIELD DC INPUT CONTROLLER DOWN-STREAM OF TRANSFORMER 1RT1. THE N.O. CONTACT IS ARRANGED IN SERIES WITH CONTACTS OF RELAYS 1KR1 & 1KR3 WHICH CLOSE TO ENERGIZE RELAY 1KRX.	a. N.O. CONTACT FAILS CLOSED	LOSS OF ABILITY TO DISABLE THE HOIST CONTROLS IF POWER FROM TRANSFORMER 1RT1 IS LOST. MULTIPLE FAILURE REQUIRED.	NO EFFECT.	3
			a. COIL FAILS OPEN	CONTACT REMAINS IN DE-ENERGIZED POSITION. RELAY 1KRX WILL REMAIN DEENERGIZED. HOIST CONTROLS WILL REMAIN DISABLED. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	RELAY 1KRX WILL REMAIN DEENERGIZED. HOIST CONTROLS WILL REMAIN DISABLED. DELAY OF OPERATIONS.	NO EFFECT.	3
1KR3	RELAY	MONITORS POWER SUPPLIED TO THE GENERATOR FIELD DC INPUT CONTROLLER DOWN-STREAM OF TRANSFORMER 1RT2. THE N.O. CONTACT IS ARRANGED IN SERIES WITH CONTACTS OF RELAYS 1KR1 & 1KR2 WHICH CLOSE TO ENERGIZE RELAY 1KRX.	a. N.O. CONTACT FAILS CLOSED	LOSS OF ABILITY TO DISABLE THE HOIST CONTROLS IF POWER FROM TRANSFORMER 1RT1 IS LOST. MULTIPLE FAILURE REQUIRED.	NO EFFECT.	3
			a. COIL FAILS OPEN	CONTACT REMAINS IN DE-ENERGIZED POSITION. RELAY 1KRX WILL REMAIN DEENERGIZED. HOIST CONTROLS WILL REMAIN DISABLED. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	RELAY 1KRX WILL REMAIN DEENERGIZED. HOIST CONTROLS WILL REMAIN DISABLED. DELAY OF OPERATIONS.	NO EFFECT.	3

Table 26 (Page 3 of 14). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 14 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1RF1, 1RF2	FUSE, 8A	PROVIDES PROTECTION AGAINST AN OVERCURRENT CONDITION UPSTREAM OF TRANSFORMER 1RT1.	a. N.O. CONTACT FAILS CLOSED	LOSS OF ABILITY TO DISABLE THE HOIST CONTROLS IF POWER FROM TRANSFORMER 1RT2 IS LOST. MUL- TIPLE FAILURE REQUIRED.	NO EFFECT.	3
			a. PREMATURE ACTUATION	RELAYS 1KR1. & 1KR2 WILL BE DEEN- ERGIZED WHICH WILL DISABLE THE HOIST CONTROLS. THE BRAKES WILL SET. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. FAILS TO ACTUATE	TRANSFORMER 1RT1 AND GENERATOR FIELD DC INPUT CONTROLLER MAY BE EXPOSED TO HIGHER THAN EXPECTED CURRENTS. POSSIBLE DAMAGE TO THESE COMPONENTS. MULTIPLE FAILURE REQUIRED.	NO EFFECT.	3
1RF3	FUSE, 15A	PROVIDES PROTECTION AGAINST AN OVERCURRENT CONDITION DOWNSTREAM OF TRANSFORMER 1RT1.	a. PREMATURE ACTUATION	RELAY 1KR1 WILL BE DEENERGIZED WHICH WILL DISABLE THE HOIST CON- TROLS. THE BRAKES WILL SET. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. FAILS TO ACTUATE	GENERATOR FIELD DC INPUT CON- TROLLER MAY BE EXPOSED TO HIGHER THAN EXPECTED CURRENTS. POSSIBLE DAMAGE TO THIS COMPO- NENT. MULTIPLE FAILURE REQUIRED.	NO EFFECT.	3
1RF4	FUSE, 15A	PROVIDES PROTECTION AGAINST AN OVERCURRENT CONDITION DOWNSTREAM OF TRANSFORMER 1RT1.	a. PREMATURE ACTUATION	RELAY 1KR2 WILL BE DEENERGIZED WHICH WILL DISABLE THE HOIST CON- TROLS. THE BRAKES WILL SET. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. FAILS TO ACTUATE	GENERATOR FIELD DC INPUT CON- TROLLER MAY BE EXPOSED TO HIGHER THAN EXPECTED CURRENTS. POSSIBLE DAMAGE TO THIS COMPO- NENT. MULTIPLE FAILURE REQUIRED.	NO EFFECT.	3

Table 26 (Page 4 of 14). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 14 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1RF5, 1RF6	FUSE, .5A	PROVIDES PROTECTION AGAINST AN OVERCURRENT CONDITION UPSTREAM OF TRANSFORMER 1RT2.	a. PREMATURE ACTUATION a. FAILS TO ACTUATE	RELAY 1KR3 WILL BE DEENERGIZED WHICH WILL DISABLE THE HOIST CONTROLS. THE BRAKES WILL SET. DELAY OF OPERATIONS. TRANSFORMER 1RT2 AND GENERATOR FIELD DC INPUT CONTROLLER MAY BE EXPOSED TO HIGHER THAN EXPECTED CURRENTS. POSSIBLE DAMAGE TO THESE COMPONENTS. MULTIPLE FAILURE REQUIRED.	NO EFFECT. NO EFFECT.	3 3
1RF7, 1RF8	FUSE, .5A	PROVIDES PROTECTION AGAINST AN OVERCURRENT CONDITION DOWNSTREAM OF TRANSFORMER 1RT2.	a. PREMATURE ACTUATION a. FAILS TO ACTUATE	RELAY 1KR3 WILL BE DEENERGIZED WHICH WILL DISABLE THE HOIST CONTROLS. THE BRAKES WILL SET. DELAY OF OPERATIONS. GENERATOR FIELD DC INPUT CONTROLLER MAY BE EXPOSED TO HIGHER THAN EXPECTED CURRENTS. POSSIBLE DAMAGE TO THIS COMPONENT. MULTIPLE FAILURE REQUIRED.	NO EFFECT. NO EFFECT.	3 3
1RT1	ISOLATION TRANSFORMER	STEPS DOWN THE BUS VOLTAGE OF 480V TO THE DESIRED VOLTAGE OF 240V FOR USE IN THE GENERATOR FIELD DC INPUT CONTROLLER.	a. FAILS OPEN OR SHORT	LOSS OF POWER TO THE GENERATOR FIELD DC INPUT CONTROLLER. RELAYS 1KR1 & 1KR2 WILL BE DEENERGIZED TO DISABLE THE HOIST CONTROL CIRCUIT. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
1RT2	CONTROL TRANSFORMER	STEPS DOWN THE BUS VOLTAGE OF 480V TO THE DESIRED VOLTAGE OF 120V FOR USE IN THE GENERATOR FIELD DC INPUT CONTROLLER.	a. FAILS OPEN OR SHORT	LOSS OF POWER TO THE GENERATOR FIELD DC INPUT CONTROLLER. RELAY 1KR3 WILL BE DEENERGIZED TO DISABLE THE HOIST CONTROL CIRCUIT. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3

Table 26 (Page 5 of 14). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 14 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1FC	GENERATOR FIELD DC INPUT CON- TROLLER	A SOLID STATE ASSEMBLY WHICH PROVIDES DC EXCITATION TO THE GENER- ATOR FIELD OF THE MOTOR-GENERATOR SET (M12-G4). THE EXCITATION IS PROPORTIONAL TO THE INPUT SUPPLIED FROM THE CONTROL POTENTIOMETERS (RPOT/FPOT) AND IS USED TO DRIVE THE DC MOTORS WHICH CONTROL THE HOIST.	a. NO OUTPUT b. CONTAMINATION, COR- ROSION, BOARD COMPO- NENT OPEN c. 09FY12-006.067 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. BRING THE MASTER CONTROLLER TO NEUTRAL OR PRESS E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	NO DC EXCITATION TO THE GENER- ATOR FIELD WINDING. NO OUTPUT FROM GENERATOR. NO HOIST MOTOR TORQUE WHILE THE COMMAND IS BEING GIVEN TO RAISE, LOWER, OR FLOAT THE LOAD AND THE BRAKES ARE RELEASED. LOAD WILL DESCEND WITH REGENERATIVE BRAKING APPLIED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. HIGH OUTPUT (NOT INVERTED) b. BOARD COMPONENT SHORT, BOARD COMPO- NENT OPEN, LOSS OF VOLTAGE FEEDBACK FROM THE DC DRIVE MOTOR LOOP c. 09FY12-006.072 d. HIGH INDICATION OF CURRENT ON CONSOLE AMMETER, OR SPEED ON THE SELSYN e. BRING THE MASTER CONTROLLER TO NEUTRAL OR PRESS E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	INCREASE IN SPEED OF THE DC MOTORS CONTROLLING THE HOIST IN THE DIRECTION COMMANDED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2

Table 26 (Page 6 of 14). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 14 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1XR1	RELAY	ENABLES THE GENERATOR FIELD DC INPUT CONTROLLER WHEN RELAY 1HCR OR 1LCR IS ENERGIZED.	a. HIGH OUTPUT (INVERTED) b. BOARD COMPONENT SHORT c. 09FY12-006.073 d. HIGH INDICATION OF CURRENT ON CONSOLE AMMETER, OR SPEED ON THE SELSYN e. BRING THE MASTER CONTROLLER TO NEUTRAL OR PRESS E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	INCREASE IN SPEED OF THE DC MOTORS CONTROLLING THE HOIST, IN THE OPPOSITE DIRECTION THAN COM- MANDED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. COIL FAILS OPEN b. CORROSION, FATIGUE c. 09FY12-006.068 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. BRING THE MASTER CONTROLLER TO NEUTRAL OR PRESS E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	CONTACTS REMAIN IN DE-ENERGIZED POSITION. NO DC EXCITATION TO THE GENERATOR FIELD. NO OUTPUT FROM GENERATOR. NO HOIST MOTOR TORQUE WHILE THE COMMAND IS BEING GIVEN, VIA THE MASTER CONTROL SWITCH, TO RAISE OR LOWER AND THE BRAKES ARE RELEASED. LOAD WILL DESCEND WITH REGENERATIVE BRAKING APPLIED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2

Table 26 (Page 7 of 14). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 Sheet No. 13/15/16 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 14 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
		N.O. CONTACT CLOSURES TO ENABLE THE SPEED REGU- LATOR IN THE GENERATOR FIELD DC INPUT CON- TROLLER.	a. N.O. CONTACT FAILS OPEN b. CORROSION, BINDING MECHANISM c. 09FY12-006.069 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. BRING THE MASTER CONTROLLER TO NEUTRAL OR PRESS E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	THE SPEED REGULATOR IN THE GEN- ERATOR FIELD DC INPUT CONTROLLER WILL NOT BE ENABLED. NO DC EXCITATION TO THE GENERATOR FIELD. NO OUTPUT FROM GENER- ATOR. NO HOIST MOTOR TORQUE WHILE THE COMMAND IS BEING GIVEN, VIA THE MASTER CONTROL SWITCH, TO RAISE OR LOWER AND THE BRAKES ARE RELEASED. LOAD WILL DESCEND WITH REGENERATIVE BRAKING APPLIED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. N.O. CONTACT FAILS CLOSED	THE SPEED REGULATOR IN THE GEN- ERATOR FIELD DC INPUT CONTROLLER WILL REMAIN ENABLED. POSSIBLE DAMAGE TO THIS COMPONENT.	NO EFFECT.	3
		N.O. CONTACT CLOSURES TO ENABLE THE BI-DIRECTIONAL AMPLIFIER IN THE GENER- ATOR FIELD DC INPUT CON- TROLLER.	a. N.O. CONTACT FAILS OPEN b. CORROSION, BINDING MECHANISM c. 09FY12-006.070 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. BRING THE MASTER CONTROLLER TO NEUTRAL OR PRESS E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	THE BI-DIRECTIONAL AMPLIFIER IN THE GENERATOR FIELD DC INPUT CONTROLLER WILL NOT BE ENABLED. NO DC EXCITATION TO THE GENER- ATOR FIELD. NO OUTPUT FROM GEN- ERATOR. NO HOIST MOTOR TORQUE WHILE THE COMMAND IS BEING GIVEN, VIA THE MASTER CONTROL SWITCH, TO RAISE OR LOWER AND THE BRAKES ARE RELEASED. LOAD WILL DESCEND WITH REGENERATIVE BRAKING APPLIED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2

Table 26 (Page 8 of 14). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 Sheet No. 13/15/16 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 14 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
		N.O. CONTACT CLOSES TO ENABLE THE FIRING CIRCUIT IN THE GENERATOR FIELD DC INPUT CONTROLLER.	a. N.O. CONTACT FAILS CLOSED	THE BI-DIRECTIONAL AMPLIFIER IN THE GENERATOR FIELD DC INPUT CONTROLLER WILL REMAIN ENABLED. POSSIBLE DAMAGE TO THIS COMPO- NENT.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN b. CORROSION, BINDING MECHANISM c. 09FY12-006.071 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. BRING THE MASTER CONTROLLER TO NEUTRAL OR PRESS E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	THE FIRING CIRCUIT IN THE GENER- ATOR FIELD DC INPUT CONTROLLER WILL NOT BE ENABLED. NO DC EXCITATION TO THE GENERATOR FIELD. NO OUTPUT FROM GENER- ATOR. NO HOIST MOTOR TORQUE WHILE THE COMMAND IS BEING GIVEN, VIA THE MASTER CONTROL SWITCH, TO RAISE OR LOWER AND THE BRAKES ARE RELEASED. LOAD WILL DESCEND WITH REGENERATIVE BRAKING APPLIED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. N.O. CONTACT FAILS CLOSED	THE FIRING CIRCUIT IN THE GENER- ATOR FIELD DC INPUT CONTROLLER WILL REMAIN ENABLED. POSSIBLE DAMAGE TO THIS COMPONENT.	NO EFFECT.	3

System 175-TON BRIDGE CRANE, VAB
Subsystem MAIN HOIST
Drawing No. 67-K-L-11348 Sheet No. 13/15/16
PMN K60-0528

Program SPACE SHUTTLE

Station Set/Facility Code TA
Date JULY 1993
Reference Figure Used 10, 11, 14
Prepared By C. CRABB, LSOC 52-11

FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
ISYNT, ISYNR1	SYNCHRO TRANS-MITTER AND RECEIVER ASSEMBLY (SELSYN)	PROVIDES HOIST POSITION AND MOTION INDICATION TO THE OPERATOR IN CAB. THE OPERATOR USES THIS INDICATOR TO DETERMINE MOVEMENT DISTANCE WHEN REQUIRED TO MAKE SMALL INCREMENTAL MOVES FOR MATE/DEDATE OPERATIONS.	a. ERRONEOUS OUTPUT (INDICATION) b. CORROSION, BINDING MECHANISM c. 09FY12-006.103 d. LOAD MOVEMENT NOT CORRESPONDING WITH CHANGE ON CONSOLE METER e. RETURN THE MASTER CONTROLLER TO NEUTRAL f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	LOSS OF ACCURATE POSITION. INDICATION OR LOAD MOTION INDICATION COULD RESULT IN IMPROPER LOAD POSITIONING.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
1FLT	RELAY	ENERGIZED WHEN THE FOOT SWITCH, S2, IS ENGAGED FOR FLOAT MODE OPERATIONS. THIS PREVENTS THE TIME DELAY RELAY, 1TDHC, FROM BEING ENERGIZED AND BYPASSING THE OVER-VOLTAGE RELAY, 1FOV, WHEN THE SPEED SELECTOR SWITCH, SS2, IS IN THE COARSE SPEED POSITION.	a. COIL FAILS OPEN	CONTACT REMAINS IN DE-ENERGIZED POSITION. THE TIME DELAY RELAY WILL BE ENERGIZED AND BYPASS THE OVERVOLTAGE RELAY WHEN THE SPEED SELECTOR SWITCH, SS2, IS IN THE COARSE SPEED POSITION AND THE OPERATOR IS FLOATING THE LOAD. MULTIPLE FAILURE REQUIRED TO RESULT IN DAMAGE TO A VEHICLE SYSTEM.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	THE TIME DELAY RELAY WILL NOT BE ENERGIZED AND WILL NOT BYPASS THE OVERVOLTAGE RELAY. IF THE CRANE IS OPERATING IN THE COARSE SPEED MODE, THE OVERVOLTAGE RELAY WILL SHUT DOWN THE M-G SET WHEN THE VOLTAGE IN THE DC MOTOR LOOP REACHES 115% OF THE FULL FINE OUTPUT.	NO EFFECT.	3

Table 26 (Page 10 of 14). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 Sheet No. 13/15/16 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 14 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1FOV	RELAY	PROTECTS AGAINST AN OVERVOLTAGE CONDITION IN THE DC MOTOR LOOP WHICH CAN RESULT IN A SPEED INCREASE OF THE HOIST. IT IS CONFIGURED TO SHUT DOWN THE M-G SET IF AN OVERVOLTAGE CONDITION (115% OF THE FULL FINE OUTPUT) IS DETECTED IN THE DC MOTOR LOOP WHILE IN THE FINE SPEED OR FLOAT MODE OF OPERATION.	a. N.C. CONTACT FAILS CLOSED	THE TIME DELAY RELAY WILL BE ENERGIZED AND BYPASS THE OVER- VOLTAGE RELAY WHEN THE SPEED SELECTOR SWITCH, SS2, IS IN THE COARSE SPEED POSITION AND THE OPERATOR IS FLOATING THE LOAD. MULTIPLE FAILURE REQUIRED TO RESULT IN DAMAGE TO A VEHICLE SYSTEM.	NO EFFECT.	3
			a. COIL FAILS OPEN	N.O. CONTACT WILL REMAIN IN THE DE-ENERGIZED POSITION. HOIST M-G SET CANNOT BE STARTED. DELAY OF OPERATION.	NO EFFECT.	3
			a. COIL FAILS TO DEENER- GIZE	LOSS OF ABILITY TO SHUT DOWN THE M-G SET IF AN OVERVOLTAGE CONDI- TION EXISTS IN THE DC MOTOR LOOP. MULTIPLE FAILURE REQUIRED TO RESULT IN DAMAGE TO A VEHICLE SYSTEM.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	HOIST M-G SET CANNOT BE STARTED. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	LOSS OF ABILITY TO SHUT DOWN THE M-G SET IF AN OVERVOLTAGE CONDI- TION EXISTS IN THE DC MOTOR LOOP. MULTIPLE FAILURE REQUIRED TO RESULT IN DAMAGE TO A VEHICLE SYSTEM.	NO EFFECT.	3

Table 26 (Page 11 of 14). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 14 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1FOV TRIP LIGHT	INDICATOR LIGHT	N.C. CONTACT CONTROLS POWER TO THE FOV TRIP LIGHT WHICH IS USED TO VERIFY PROPER OPERATION OF THIS RELAY DURING THE PRE-OPS CHECK.	a. N.C. CONTACT FAILS OPEN	FOV TRIP LIGHT WILL NOT COME ON. DELAY OF OPERATION.	NO EFFECT.	3
		LIGHTS WHEN THE FOV CONTACTS ARE IN THE DEENERGIZED POSITION TO INDICATE THAT THE FOV RELAY IS DISABLED WHICH WILL PREVENT THE M-G SET FROM BEING STARTED. THIS IS EXTINGUISHED WHEN THE FOV RELAY IS ENABLED TO ALLOW FOR M-G SET START.	a. N.C. CONTACT FAILS CLOSED	FOV TRIP LIGHT WILL REMAIN ON. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAIL OPEN	FAILS TO INDICATE THE PROPER OPERATION OF THE FOV RELAY. DELAY OF OPERATION.	NO EFFECT.	3
1FOV RECT	RECTIFIER, BRIDGE	MAINTAINS A POSITIVE VOLTAGE INPUT TO RELAY 1FOV REGARDLESS OF THE VOLTAGE POLARITY AND CURRENT DIRECTION IN THE DC MOTOR LOOP.	a. DIODE FAILS OPEN/SHORTED	NO INPUT FROM THE DC MOTOR LOOP TO THE OVERVOLTAGE RELAY. LOSS OF ABILITY TO SHUT DOWN THE M-G SET IF AN OVERVOLTAGE CONDITION EXISTS IN THE DC MOTOR LOOP. MULTIPLE FAILURE REQUIRED TO RESULT IN DAMAGE TO A VEHICLE SYSTEM.	NO EFFECT.	3

Table 26 (Page 12 of 14). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 14 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1TDHC	RELAY, TIME DELAY	BYPASSES THE OVER- VOLTAGE RELAY, 1FOV, WHEN ENERGIZED BY POSITIONING THE SPEED SELECTOR SWITCH, SS2 TO COARSE SPEED. THE TIME DELAY IS SET TO PROVIDE TIME FOR THE VOLTAGE IN THE DC MOTOR LOOP TO GO BELOW THE 115% FULL FINE VOLTAGE THRESHOLD WHEN THE SPEED SELECTOR SWITCH IS POSITIONED FROM COARSE TO FINE SPEED WHILE THE CRANE IS IN MOTION. THIS PREVENTS INADVERTENT SHUT DOWNS OF THE M-G SET.	a. COIL FAILS OPEN	N.O. CONTACT WILL REMAIN IN THE DE-ENERGIZED POSITION AND WON'T BYPASS THE OVERVOLTAGE RELAY. IF THE CRANE IS OPERATING IN THE COARSE SPEED MODE, THE OVER- VOLTAGE RELAY WILL SHUT DOWN THE M-G SET WHEN THE VOLTAGE IN THE DC MOTOR LOOP REACHES 115% OF THE FULL FINE OUTPUT.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	THE OVERVOLTAGE RELAY WON'T BE BYPASSED IF THE CRANE IS OPER- ATING IN THE COARSE SPEED MODE, THE OVERVOLTAGE RELAY WILL SHUT DOWN THE M-G SET WHEN THE VOLTAGE IN THE DC MOTOR LOOP REACHES 115% OF THE FULL FINE OUTPUT.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	THE OVERVOLTAGE RELAY WILL BE BYPASSED WHEN THE SPEED SELECTOR SWITCH IS IN THE FINE SPEED POSITION. MULTIPLE FAILURE REQUIRED TO RESULT IN DAMAGE TO A VEHICLE SYSTEM.	NO EFFECT.	3

Table 26 (Page 13 of 14). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 14 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1TDHH	RELAY, TIME DELAY	N.O. CONTACT CLOSURES TO ILLUMINATE THE INDICATOR WHICH SHOWS THAT THE TIME DELAY RELAY IS ENERGIZED AND BYPASSING THE OVERVOLTAGE RELAY. BYPASSES THE OVERVOLTAGE RELAY, 1FOV, WHEN ENERGIZED BY POSITIONING THE SPEED SELECTOR SWITCH, SS2, TO HIGH SPEED.	a. N.O. CONTACT FAILS OPEN	NO INDICATION THAT THE RELAY IS ENERGIZED. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	THE INDICATION THAT THE RELAY IS ENERGIZED WILL BE ILLUMINATED CONSTANTLY. DELAY OF OPERATION.	NO EFFECT.	3
			a. COIL FAILS OPEN	N.O. CONTACT WILL REMAIN IN THE DE-ENERGIZED POSITION AND WON'T BYPASS THE OVERVOLTAGE RELAY. IF THE CRANE IS OPERATING IN THE HIGH SPEED MODE, THE OVERVOLTAGE RELAY WILL SHUT DOWN THE M-G SET WHEN THE VOLTAGE IN THE DC MOTOR LOOP REACHES 115% OF THE FULL FINE OUTPUT.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	THE OVERVOLTAGE RELAY WON'T BE BYPASSED. IF THE CRANE IS OPERATING IN THE HIGH SPEED MODE, THE OVERVOLTAGE RELAY WILL SHUT DOWN THE M-G SET WHEN THE VOLTAGE IN THE DC MOTOR LOOP REACHES 115% OF THE FULL FINE OUTPUT.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	THE OVERVOLTAGE RELAY WILL BE BYPASSED WHEN THE SPEED SELECTOR SWITCH IS IN THE FINE SPEED POSITION. MULTIPLE FAILURE REQUIRED TO RESULT IN DAMAGE TO A VEHICLE SYSTEM.	NO EFFECT.	3

Table 26 (Page 14 of 14). ELECTRICAL FMEA - MAIN HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem MAIN HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 10, 11, 14 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
		N.O. CONTACT CLOSURES TO ILLUMINATE THE INDICATOR WHICH SHOWS THAT THE TIME DELAY RELAY IS ENERGIZED AND BYPASSING THE OVERVOLTAGE RELAY.	a. N.O. CONTACT FAILS OPEN a. N.O. CONTACT FAILS CLOSED	NO INDICATION THAT THE RELAY IS ENERGIZED. DELAY OF OPERATION. THE INDICATION THAT THE RELAY IS ENERGIZED WILL BE ILLUMINATED CONSTANTLY. DELAY OF OPERATION.	NO EFFECT. NO EFFECT.	3 3

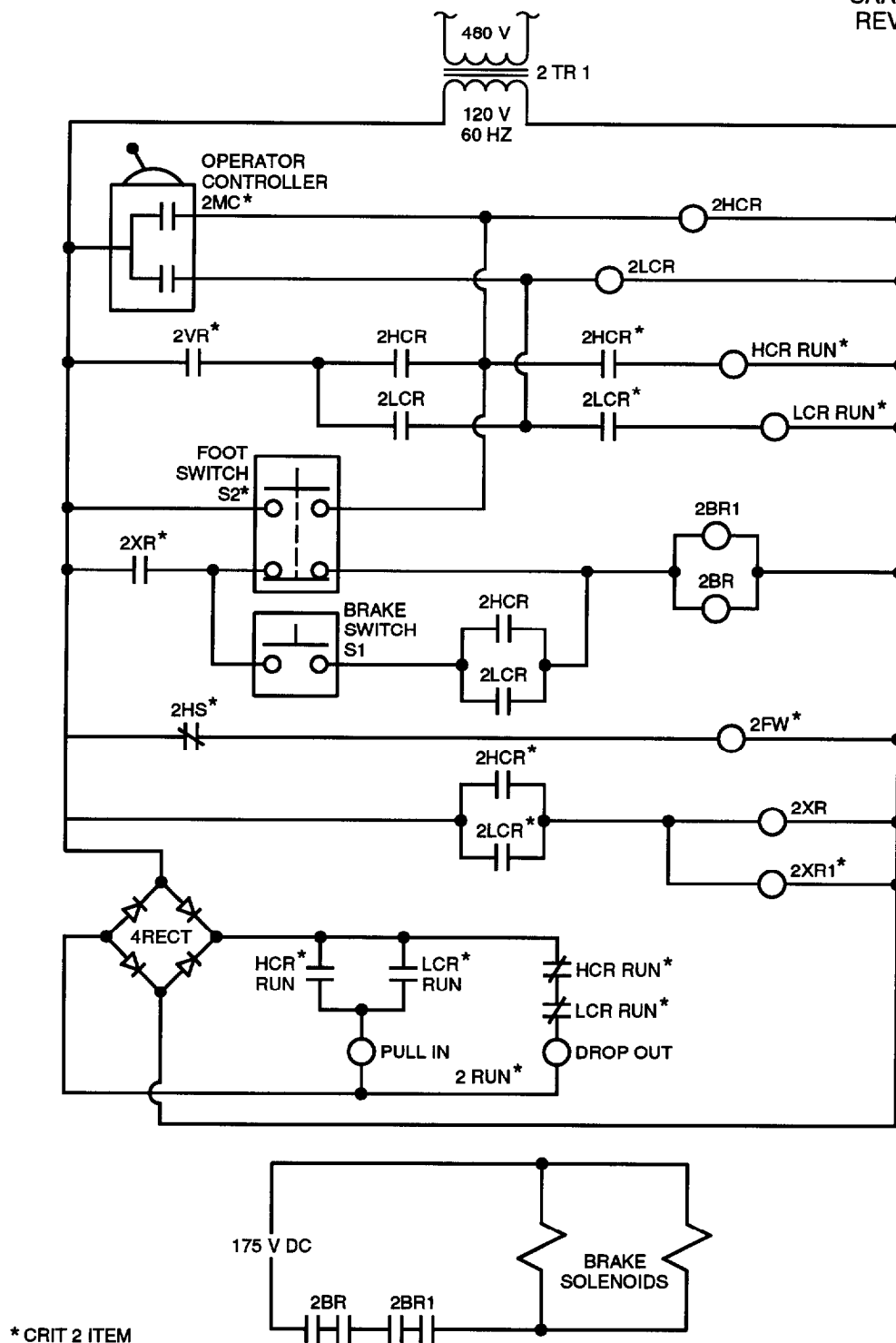


FIGURE 15. AUXILIARY HOIST ELECTRICAL CONTROL SIMPLIFIED SCHEMATIC (1 OF 3)

125

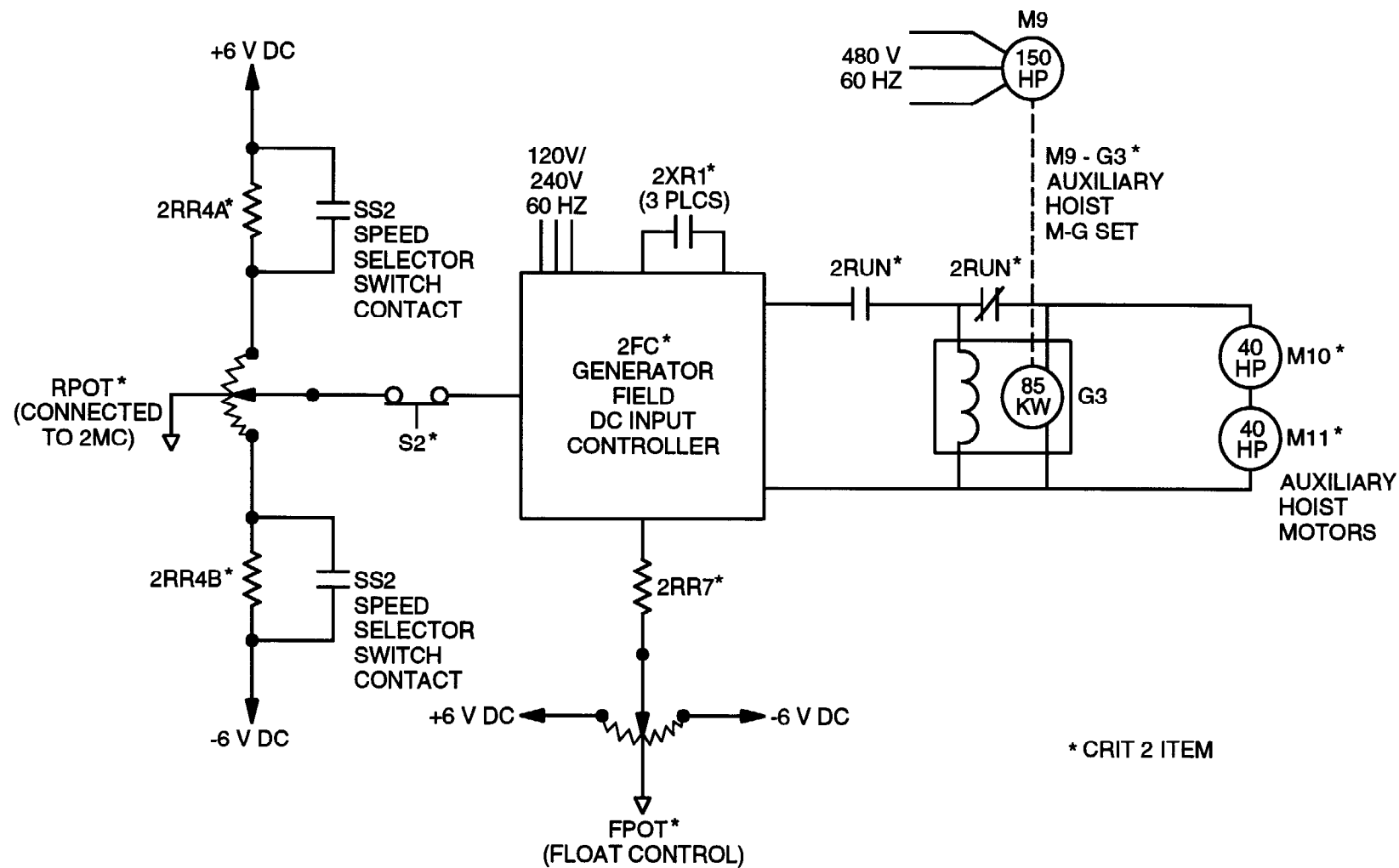


FIGURE 16. AUXILIARY HOIST ELECTRICAL CONTROL SIMPLIFIED SCHEMATIC (2 OF 3)

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REV. B

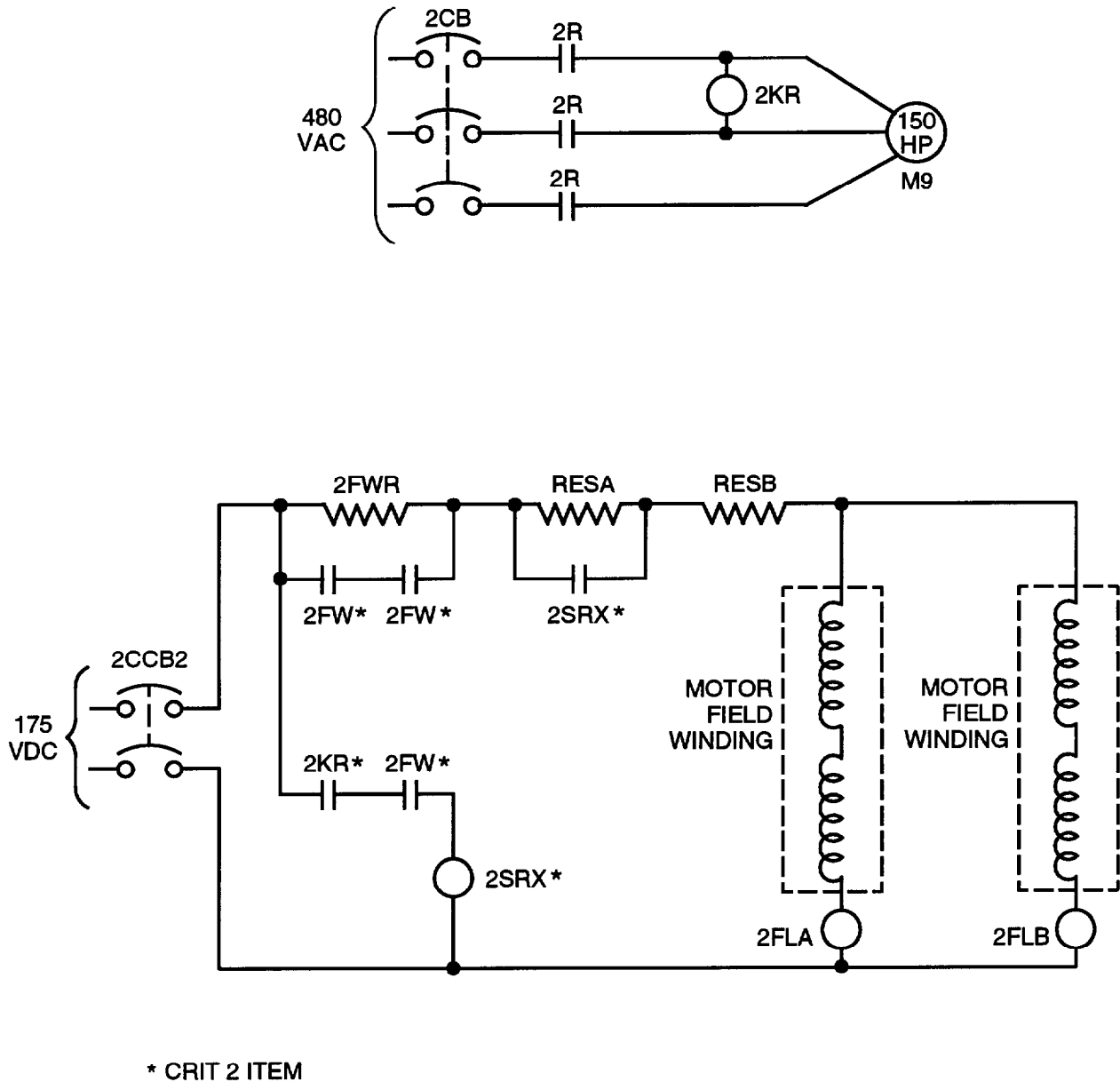


FIGURE 17. AUXILIARY HOIST ELECTRICAL CONTROL SIMPLIFIED SCHEMATIC (3 OF 3)

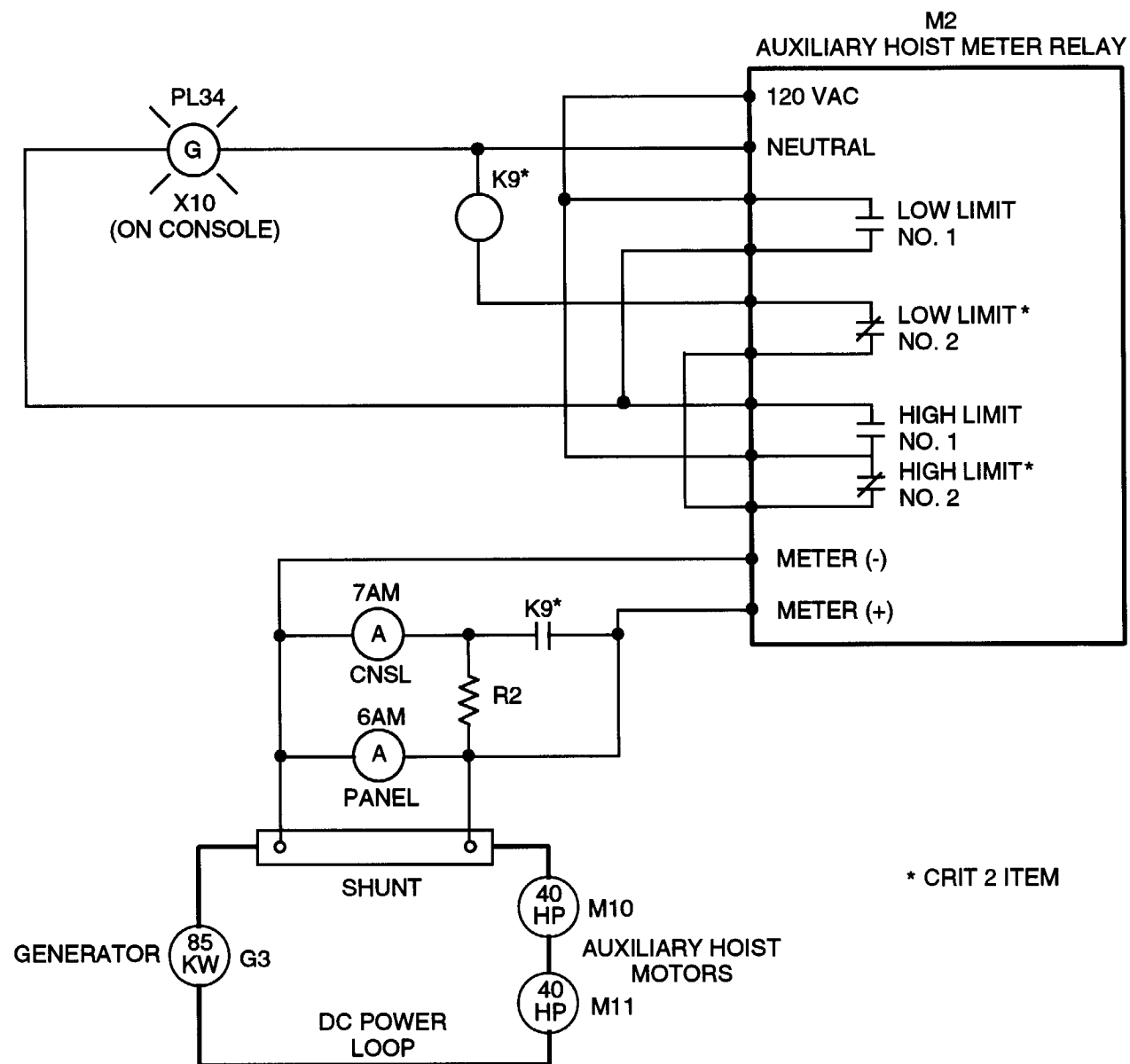


FIGURE 18. AUXILIARY HOIST METER RELAY SCHEMATIC

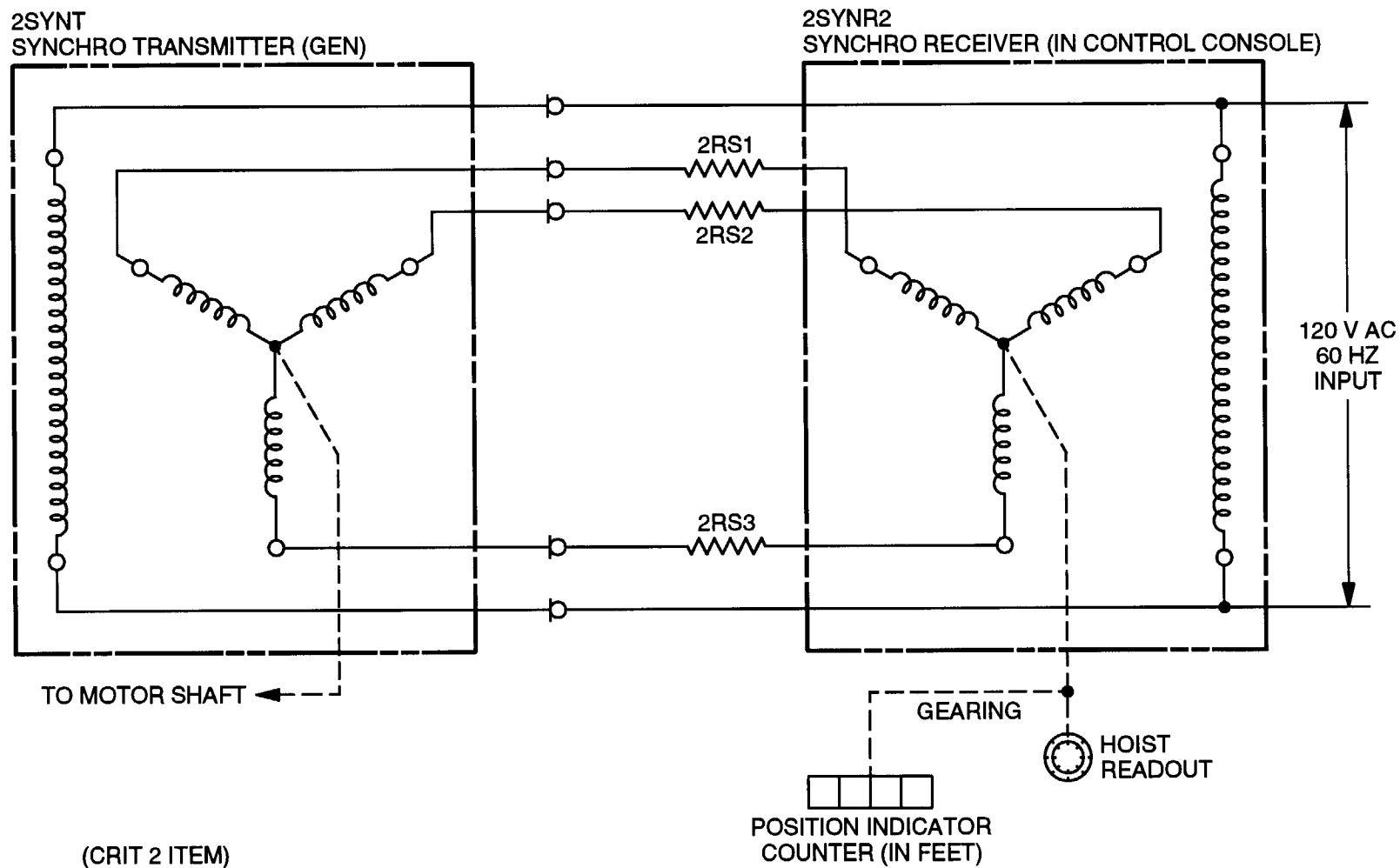


FIGURE 19. AUXILIARY HOIST SYNCHRO TRANSMITTER AND RECEIVER (SELSYN)

Table 27 (Page 1 of 3). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 11/12/18/19 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 16 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2CB	CIRCUIT BREAKER, 350AT	PROVIDES OVERLOAD PRO- TECTION FOR HOIST CIRCU- ITRY. CONTACT PROVIDES LATCHING FOR START RELAY 2SR. PROVIDES THE ABILITY TO SHUT THE HOIST DOWN AND SET THE BRAKES WHEN THE SHUNT TRIP IS ENERGIZED BY THE PHASE REVERSAL RELAY.	a. PREMATURE TRIP	LOSS OF POWER TO THE HOIST CONTROL CIRCUITRY. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAILS TO TRIP	POSSIBLE DAMAGE TO HOIST CIRCU- ITRY. UPSTREAM CB (MCB) MAY TRIP RESULTING IN LOSS OF POWER TO MAIN BUS. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	M-G SET WILL NOT STAY RUNNING WHEN START BUTTON IS RELEASED. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	NO EFFECT ON STARTING OR RUNNING M-G SET.	NO EFFECT.	3
			a. SHUNT TRIP FAILS OPEN	LOSS OF ABILITY TO SHUT DOWN THE HOIST BY THE PHASE REVERSAL RELAY. POSSIBLE DAMAGE TO THE CRANE CONTROL CIRCUITRY. MUL- TIPLE FAILURE REQUIRED.	NO EFFECT	3
1OL 2OL 3OL	OVERLOAD	PROVIDES OVERLOAD PRO- TECTION IN EACH OF THE THREE LEGS OF THE MOTOR OF THE M-G SET. THREE N.C. CONTACTS, ARRANGED IN SERIES, OPEN TO SHUT DOWN THE M-G SET.	a. PREMATURE ACTUATION	SHUTDOWN OF THE M-G SET CAUSING HOIST TO STOP. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAILS TO ACTUATE	POSSIBLE DAMAGE TO THE MOTOR IN THE M-G SET. UPSTREAM CB (2CB) MAY TRIP, RESULTING IN LOSS OF POWER TO THE M-G SET. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3

Table 27 (Page 2 of 3). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 11/12/18/19 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 16 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
M9-G3	MOTOR- GENERATOR (M-G) SET, 150 HP - 85KW	CONSISTS OF A 150 HP MOTOR COUPLED TO AN 85KW DC GENERATOR TO PROVIDE POWER TO THE ARMATURES OF THE TWO 40 HP HOIST MOTORS.	a. N.C. CONTACT FAILS CLOSED	BACKUP CONTACT IN SERIES WILL OPEN TO SHUT DOWN M-G SET.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	M-G WILL NOT RUN. DELAY OF OPER- ATION.	NO EFFECT.	3
			a. NO OUTPUT b. BRUSH/COMMUTATOR FAILURE, OPEN/SHORTED ARMATURE WINDING, STRUCTURAL FAILURE (BRUSH SPRING, BRUSH YOKE, BRUSH RIGGING), OPEN/SHORTED FIELD WINDING. c. 09FY12-006.035 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	LOSS OF HOIST MOTOR ARMATURE CURRENT. LOSS OF HOIST MOTOR TORQUE WHILE THE COMMAND IS BEING GIVEN TO RAISE, LOWER OR FLOAT AND THE BRAKES ARE RELEASED. LOAD WILL DESCEND.	POSSIBLE DAMAGE OF A VEHICLE SYSTEM.	2

Table 27 (Page 3 of 3). **ELECTRICAL FMEA - AUXILIARY HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 16 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
M10, M11	MOTORS, 40 HP EACH	TWO SHUNT WOUND DC MOTORS WITH THE ARMA- TURES ARRANGED IN SERIES TO PROVIDE MECHANICAL TORQUE TO RAISE, LOWER OR HOLD THE LOAD. THE FIELD WINDINGS, F1-F2 & F3-F4, PROVIDE A CONSTANT MAGNETIC FIELD TO WORK AGAINST THE VARYING MAG- NETIC FIELD OF THE ARMA- TURE LOOP TO PRODUCE TORQUE.	a. OPEN ARMATURE WINDING b. BRUSH/COMMUTATOR FAILURE, OPEN/SHORTED ARMATURE WINDING, STRUCTURAL FAILURE (BRUSH SPRING, BRUSH YOKE, BRUSH RIGGING), OPEN/SHORTED CABLE OR CONNECTOR. c. 09FY12-006.063 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. PRESS E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	LOSS OF ARMATURE DC CURRENT TO BOTH MOTORS. LOSS OF HOIST MOTOR TORQUE WHILE THE COMMAND IS GIVEN TO RAISE, LOWER OR FLOAT LOAD AND THE BRAKES ARE RELEASED. LOAD WILL DESCEND.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. OPEN FIELD WINDING	RELAY 2FLA OR 2FLB WILL BE DE-ENERGIZED AND OPEN CONTACTS TO SHUT DOWN M-G SET. DELAY OF OPERATION.	NO EFFECT.	3

Table 28. ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 17 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
20S1	M-G OVER- SPEED SENSOR	PROVIDES CAPABILITY TO SHUT DOWN THE M-G SET IF AN OVERSPEED CONDITION EXISTS.	a. N.C. CONTACT FAILS CLOSED	LOSS OF M-G OVERSPEED PRO- TECTION. POSSIBLE DAMAGE TO THE M-G SET WHEN COUPLED WITH M-G OVERSPEED.	NO EFFECT.	3
OTG	GENERATOR OVERTEM- PERATURE SENSOR	PROVIDES CAPABILITY TO SHUT DOWN THE M-G SET IF AN OVERTEMPERATURE CON- DITION EXISTS.	a. N.C. CONTACT FAILS OPEN	UNABLE TO START M-G SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	LOSS OF GENERATOR OVERTEMPER- ATURE PROTECTION. POSSIBLE DAMAGE TO THE M-G SET WHEN COUPLED WITH GENERATOR OVER- TEMPERATURE CONDITION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	UNABLE TO START M-G SET. DELAY OF OPERATION.	NO EFFECT.	3

Table 29 (Page 1 of 4). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2CCB	CIRCUIT BREAKER, 30AT	PROVIDES OVERLOAD PRO- TECTION FOR CIRCUIT PRO- VIDING POWER TO THE HOIST M-G SET.	a. PREMATURE TRIP	LOSS OF POWER TO THE HOIST STARTER CONTROLS. THE HOIST WILL STOP. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAILS TO TRIP	POSSIBLE DAMAGE TO THE HOIST CIRCUITRY. UPSTREAM CB (2CB) MAY TRIP. LOSS OF POWER TO THE HOIST M-G SET. BRAKES WILL SET. DELAY IN OPERATIONS.	NO EFFECT.	3
2TR	RELAY, TIME DELAY	PROVIDES TIMED DELAY FOR DROPPING OUT THE START CIRCUIT AND PICKING UP THE RUN CIRCUIT DURING THE START OF THE HOIST M-G SET.	a. COIL FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. M-G SET WILL NOT GET FULL POWER. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	M-G SET WILL NOT GET FULL POWER. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	M-G SET WILL GET FULL POWER WHEN START BUTTON IS PUSHED, POSSIBLE CAUSING CURRENT OVERLOAD TO TRIP. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	M-G SET WILL NOT GET FULL POWER. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	M-G SET WILL GET FULL POWER WHEN START BUTTON IS PUSHED, POSSIBLE CAUSING CURRENT OVERLOAD TO TRIP. DELAY OF OPERATION.	NO EFFECT.	3
2Y	RELAY	CONTROLS STARTING CURRENT FOR THE HOIST M-G SET.	a. COIL FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. M-G SET WILL NOT START PROPERLY. EXCES- SIVE START-UP CURRENT TO M-G SET WOULD CAUSE M-G SET OVERLOADS TO TRIP. DELAY OF OPERATION.	NO EFFECT.	3

Table 29 (Page 2 of 4). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 18 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2S	RELAY	ENERGIZES WHEN THE M-G SET IS STARTED TO PROVIDE LATCHING FOR RELAY 2SR (START RELAY). THIS ALSO CONTROLS THE STARTING CURRENT FOR THE HOIST M-G SET.	a. N.O. CONTACT FAILS OPEN	M-G SET WILL NOT START PROPERLY. EXCESSIVE START-UP CURRENT TO M-G SET WOULD CAUSE M-G SET OVERLOADS TO TRIP. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	CURRENT WILL BYPASS THIS PORTION OF THE CIRCUIT THROUGH RELAY CONTACT 2R (RUN RELAY). NO EFFECT ON CRANE OPERATION. RELAY CONTACT 2S WILL OPEN TO REMOVE POWER FROM THE START CIRCUIT.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	NO EFFECT ON STARTING OR RUNNING OF M-G SET. SERIES ARRANGED CONTACT OF 2TR RELAY WILL NOT ALLOW RELAY 2R TO ENERGIZE UNTIL THE PROPER TIME.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	RELAY 2R WOULD NOT ENERGIZE. M-G SET WOULD NOT GET FULL POWER. DELAY OF OPERATION.	NO EFFECT.	3
			a. COIL FAILS OPEN	CONTACT WILL REMAIN IN DE-ENERGIZED POSITION. M-G SET WILL NOT START.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	M-G SET SHUT OFF AFTER THE START BUTTON IS LET UP. DELAY OF OPERATION.	NO EFFECT.	3

Table 29 (Page 3 of 4). **ELECTRICAL FMEA - AUXILIARY HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 18 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2R	RELAY	CONTROLS RUNNING CURRENT TO THE HOIST M-G SET.	a. N.O. CONTACT FAILS CLOSED	M-G SET WILL RESTART AFTER THE STOP BUTTON IS RELEASED. THE POWER CAN BE REMOVED BY OPENING CIRCUIT BREAKER 2CB. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	M-G SET WILL NOT START PROPERLY. EXCESSIVE START-UP CURRENT TO M-G SET, THROUGH RELAY CONTACT 2R (RUN RELAY), WOULD CAUSE M-G SET OVERLOADS TO TRIP. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	CURRENT WILL BYPASS THIS PORTION OF THE CIRCUIT THROUGH RELAY CONTACT 2R (RUN RELAY). NO EFFECT ON CRANE OPERATION. IF ALL THREE CONTACTS ARE HELD CLOSED THE M-G SET WILL CONTINUE TO RUN AT A REDUCED VOLTAGE WHEN COM- MANDED TO STOP. DELAY OF OPER- ATIONS.	NO EFFECT.	3
			a. COIL FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. M-G SET WILL NOT GET FULL POWER. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	IF JUST ONE CONTACT IS HELD CLOSED IT COULD CAUSE AN EXCES- SIVE START CURRENT WHICH WOULD TRIP M-G SET OVERLOADS. DELAY OF OPERATIONS. OR IF ALL THREE CONTACTS ARE HELD CLOSED THE M-G SET WILL CONTINUE TO RUN WHEN COMMANDED TO STOP. DELAY OF OPERATIONS.	NO EFFECT.	3

Table 29 (Page 4 of 4). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 18 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
			a. N.O. CONTACT FAILS OPEN	MOTOR WOULD NOT GET THE PROPER RUN CURRENT. M-G SET WILL NOT RECEIVE FULL POWER. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	RELAY 2Y WILL BE DEENERGIZED BY SERIES ARRANGED CONTACT OF 2TR. NO EFFECT ON STARTING OR RUNNING OPERATIONS.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	M-G SET WILL NOT START PROPERLY. EXCESSIVE START-UP CURRENT TO M-G SET WOULD CAUSE M-G SET OVERLOADS TO TRIP. DELAY OF OPERATION.	NO EFFECT.	3

Table 30 (Page 1 of 31). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 12/13/17/18/19/28 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2L1A, 2L2A, 2L3A	AUTOTRANS- FORMER	REGULATES THE STARTING VOLTAGE FOR MOTOR M9 IN THE M-G SET. (1 PER PHASE LEG, 3 TOTAL).	a. FAILS OPEN	MOTOR M12 WILL NOT GET THE PROPER STARTING VOLTAGE. POS- SIBLE DAMAGE TO THE M-G SET. DELAY OF OPERATIONS.	NO EFFECT.	3
2-OTT	AUTOTRANS- FORMER OVERTEM- PERATURE SENSOR	PROVIDES CAPABILITY TO SHUT DOWN THE HOIST M-G SET IF AUTOTRANSFORMER OVERHEATS.	a. N.C. CONTACT FAILS CLOSED	POSSIBLE DAMAGE TO THE M-G SET. MULTIPLE FAILURE REQUIRED. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	M-G SET WILL NOT START. DELAY OF OPERATION.	NO EFFECT.	3
2TR1	CONTROL TRANS- FORMER	STEPS DOWN THE BUS VOLTAGE OF 480V TO THE DESIRED CONTROL VOLTAGE OF 120V FOR MAIN CONTROL POWER FOR THE HOIST.	a. FAILS OPEN OR SHORT	LOSS OF CONTROL POWER. THE HOIST M-G SET WILL STOP. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
2CCB1	HOIST CONTROL POWER CIRCUIT BREAKER 15AT	PROVIDES OVERLOAD PRO- TECTION FOR CIRCUIT FUR- NISHING CONTROL POWER FOR THE HOIST.	a. PREMATURE TRIP	LOSS OF CONTROL POWER TO HOIST. M-G SET WILL STOP. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAILS TO TRIP	MULTIPLE FAILURE REQUIRED. UPSTREAM CB 2CCB MAY TRIP RESULTING IN LOSS OF POWER TO STARTING AND CONTROL CIRCUITS. M-G SET WILL STOP. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
S3	PUSH-BUTTON SWITCH, START AND STOP	PROVIDES POWER TO THE HOIST START RELAY 2SR TO START AND STOP THE M-G SET.	a. START SWITCH FAILS OPEN	UNABLE TO START M-G SET. DELAY OF OPERATION.	NO EFFECT.	3

Table 30 (Page 2 of 31). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 12/13/17/18/19/28 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
PL15	INDICATION LAMP	PROVIDES INDICATION THAT HOIST M-G SET STARTING RELAY IS ENERGIZED.	a. START SWITCH FAILS CLOSED	M-G SET WILL RESTART AFTER IT HAS BEEN SHUT DOWN WITH STOP BUTTON. M-G CAN BE SHUT DOWN BY OPENING CB 2CCB OR 2CCB1.	NO EFFECT.	3
			a. STOP SWITCH FAILS CLOSED	UNABLE TO SHUT DOWN M-G SET WITH S3. M-G CAN BE SHUT DOWN BY OPENING CB 2CCB OR 2CCB1.	NO EFFECT.	3
			a. STOP SWITCH FAILS OPEN	UNABLE TO START M-G SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAILS OPEN	UNABLE TO DETERMINE IF STARTING RELAY 2SR IS ENERGIZED. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAILS SHORT	UNABLE TO ENERGIZE STARTING RELAY 2SR. DELAY OF OPERATION.	NO EFFECT.	3
2SR	RELAY	ENABLES THE HOIST CONTROL CIRCUITRY.	a. COIL FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. UNABLE TO START M-G SET. DELAY OF OPERA- TION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	M-G SET WILL START BUT THE HOIST CANNOT BE MOVED, AND THE BRAKES CANNOT BE RELEASED WITH 2MC. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	LOSS OF ABILITY TO DISABLE 2MC WITH 2SR. TWO SERIES ARRANGED N.O. RELAY CONTACTS, 2KR & 2KRX, WILL DISABLE 2MC.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	M-G SET WILL NOT START. DELAY OF OPERATION.	NO EFFECT.	3
		N.O. CONTACT CLOSURES TO ENABLE THE HOIST MASTER CONTROL 2MC.				
		N.O. CONTACT CLOSURES TO INITIATE AND MAINTAIN THE START AND RUN SEQUENCE FOR THE HOIST M-G SET.				

Table 30 (Page 3 of 31). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 12/13/17/18/19/28 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2BR2	RELAY	N.C. CONTACT DISABLES THE OPERATION OF THE MAIN HOIST WHILE THE HOIST IS RUNNING. ENERGIZES WHEN THE HOIST M-G SET IS STARTED TO ENABLE THE BRAKE SOLENOIDS. THE TWO N.O. CONTACTS ARE IN SERIES WITH 2BR AND 2BR1 CONTACTS.	a. N.O. CONTACT FAILS CLOSED	UNABLE TO SHUT DOWN M-G SET WITH STOP BUTTON. M-G SET CAN BE SHUT DOWN BY OPENING CIRCUIT BREAKER 2CCB.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	UNABLE TO START THE MAIN HOIST. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	WILL NOT LOCK-OUT THE MAIN HOIST WHILE AUX. HOIST IS OPERATING. NO EFFECT ON AUX. HOIST OPERATION.	NO EFFECT.	3
			a. COIL FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. BRAKES WILL REMAIN SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN (1 OF 2)	BRAKES WILL REMAIN SET. DELAY OF OPERATION.	NO EFFECT.	3
2MB	RELAY	ENERGIZES TO TURN ON BLOWER MOTORS, M19 & M20, WHEN THE M-G SET IS STARTED.	a. N.O. CONTACT FAILS CLOSED (1 OF 2)	THE REDUNDANT CONTACTS IN SERIES WILL OPEN, REMOVING POWER FROM BRAKES TO SET THEM.	NO EFFECT.	3
			a. COIL FAILS OPEN	CONTACTS REMAIN IN DEENERGIZED POSITION. THE BLOWER MOTORS WILL NOT START. POSSIBLE DAMAGE TO THE DC DRIVE MOTORS. THE HOIST MOTOR WINDING TEMPERATURE SENSOR WILL SHUT DOWN THE HOIST M-G SET IF NECESSARY.	NO EFFECT.	3

Table 30 (Page 4 of 31). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2MC	MASTER CONTROL SWITCH	A "JOYSTICK" CONNECTED TO MECHANICAL CONTACTS AND REFERENCE POTENTIOMETER (RPOT), TO PROVIDE THE OPERATOR CONTROL OF THE HOIST FOR RAISING (2MC-3) OR LOWERING (2MC-2) THE LOAD AND RELEASING THE BRAKES BY ENERGIZING THE HOIST CONTROL OR LOWER CONTROL RELAYS IN THE NORMAL MODE OF OPERATION.	a. N.O. CONTACT FAILS OPEN (1 OF 3)	BLOWER MOTORS WILL NOT RECEIVE FULL POWER. POSSIBLE DAMAGE TO THE BLOWER MOTORS AND THE DC DRIVE MOTORS. THE HOIST MOTOR WINDING TEMPERATURE SENSOR WILL SHUT DOWN THE HOIST M-G SET IF NECESSARY.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED (1 OF 3)	NO EFFECT. BLOWER MOTORS WILL SHUT OFF AS EXPECTED.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	UNABLE TO DRIVE THE HOIST MOTORS AND RELEASE THE BRAKES FOR NORMAL OPERATIONS. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED b. WELDED CONTACT, BINDING MECHANISM c. 09FY12-006 036 d. BRAKE SET LIGHT WILL NOT COME ON e. PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	BRAKES WILL NOT SET WHEN MASTER CONTROL LEVER IS RETURNED TO NEUTRAL POSITION (NO ARMATURE CURRENT). LOAD WILL DESCEND WITH REGENERATIVE BRAKING APPLIED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2

Table 30 (Page 5 of 31). **ELECTRICAL FMEA - AUXILIARY HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2HCR	RELAY	N.C. CONTACT (2MC-1) OPENS WHEN THE "JOYSTICK" IS POSITIONED OUT OF DETENT TO PREVENT THE M-G SET FROM BEING STARTED.	a. N.C. CONTACT FAILS OPEN	UNABLE TO START THE M-G SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	M-G SET CAN BE STARTED WITH THE "JOYSTICK" OUT OF DETENT. OPERATOR ERROR REQUIRED.	NO EFFECT.	3
		N.O. CONTACT (2MC-4) CLOSSES TO ENERGIZE THE HIGH SPEED RELAYS WHEN THAT MODE IS SELECTED.	a. N.O. CONTACT FAILS OPEN	LOSS OF HIGH SPEED CAPABILITY. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	SPEED SELECTOR SWITCH CONTACT, SS2-5, ARRANGED IN SERIES, WILL PREVENT THE HIGH SPEED RELAYS FROM BEING ENERGIZED IF THE HIGH SPEED MODE IS NOT SELECTED.	NO EFFECT.	3
		PROVIDES POWER TO BRAKE RELAYS TO RELEASE BRAKES DURING HOISTING AND FLOATING OPERATIONS, AND PROVIDES POWER TO START THE SEQUENCE TO ENERGIZE THE GENERATOR FIELD WINDING.	a. COIL FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. BRAKES CANNOT BE RELEASED AND GENERATOR FIELD CANNOT BE ENERGIZED. DELAY OF OPERATION.	NO EFFECT.	3

Table 30 (Page 6 of 31). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
		N.O. CONTACT CLOSING TO ENERGIZE HCR RUN WHICH ENERGIZES 2RUN.	a. N.O. CONTACT FAILS OPEN b. CORROSION, BINDING MECHANISM c. 09FY12-006.037 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. RETURN THE MASTER CONTROLLER TO NEUTRAL OR PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	RELAY 2RUN N.O. CONTACT WILL NOT CLOSE AND GENERATOR FIELD WILL NOT BE ENERGIZED. NO HOIST MOTOR TORQUE. LOAD WILL DESCEND, WITH REGENERATIVE BRAKING APPLIED, WHILE THE COMMAND IS BEING GIVEN TO RAISE OR FLOAT AND THE BRAKES ARE RELEASED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. N.O. CONTACT FAILS CLOSED	POWER WILL BE REMOVED FROM RELAY HCR RUN WHEN THE MASTER CONTROL SWITCH IS RETURNED TO CENTER AND SERIES RELAY CONTACT 2VR IS DEENERGIZED.	NO EFFECT.	3
		N.O. CONTACT, ARRANGED IN SERIES WITH 2VR, CLOSING TO KEEP RELAY 2HCR ENER- GIZED WHILE THE VOLTAGE IN THE DC DRIVE MOTOR CIRCUIT IS ABOVE A PREDE- TERMINED LIMIT. THIS PRE- VENTS THE BRAKES FROM SETTING, AFTER THE MASTER CONTROL SWITCH IS RETURNED TO NEUTRAL, WHILE THE MOTORS WIND DOWN.	a. N.O. CONTACT FAILS OPEN	BRAKES WILL SET IMMEDIATELY WHEN THE MASTER CONTROL SWITCH IS RETURNED TO NEUTRAL. POSSIBLE DAMAGE TO THE BRAKES.	NO EFFECT.	3

Table 30 (Page 7 of 31). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
		N.O. CONTACT CLOSURES TO ENERGIZE RELAY 2XR, WHICH RELEASES THE BRAKES, AND RELAY 2XR1, WHICH ENABLES THE GENERATOR FIELD DC INPUT CONTROLLER.	a. N.O. CONTACT FAILS CLOSED a. N.O. CONTACT FAILS OPEN	SERIES ARRANGEMENT OF 2VR N.O. CONTACT WILL REMOVE POWER FROM 2HCR AFTER THE VOLTAGE IN THE DC MOTOR CIRCUIT GOES BELOW THE PREDETERMINED LIMIT. BRAKES WILL NOT BE RELEASED AND THE GENERATOR FIELD DC INPUT CONTROLLER WILL NOT BE ENABLED. DELAY OF OPERATIONS.	NO EFFECT. NO EFFECT.	3 3
		N.O. CONTACT CLOSURES TO ENABLE THE HAND BRAKE RELEASE SWITCH S1.	a. N.O. CONTACT FAILS CLOSED b. WELDED CONTACTS, BINDING MECHANISM c. 09FY12-006.038 d. BRAKE SET LIGHT WILL NOT COME ON e. PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	BRAKE RELAYS WILL REMAIN ENER- GIZED AND BRAKES WILL NOT SET WHEN HOIST MOTORS ARE COM- MANDED TO STOP (IN NORMAL OPER- ATION). LOAD WILL DESCEND WITH REGENERATIVE BRAKING APPLIED. GENERATOR FIELD DC INPUT CON- TROLLER WILL BE ENABLED BUT DEENERGIZED 2RUN CONTACT WILL PREVENT AN INPUT TO THE GENER- ATOR FIELD WINDING.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
		N.C. CONTACT CLOSURES TO DISABLE THE LOWERING PORTION OF THE CIRCUITRY.	a. N.O. CONTACT FAILS OPEN a. N.O. CONTACT FAILS CLOSED a. N.C. CONTACT FAILS OPEN	HAND BRAKE SWITCH S1 CANNOT RELEASE THE BRAKES. DELAY OF OPERATION. HAND BRAKE SWITCH S1 AND N.O. RELAY CONTACT 2XR, ARRANGED IN SERIES, WILL PREVENT THE BRAKES FROM BEING RELEASED INADVERT- ENTLY. RELAY 2LCR WILL REMAIN LOCKED OUT. UNABLE TO LOWER LOAD. DELAY OF OPERATION.	NO EFFECT. NO EFFECT. NO EFFECT.	3 3 3

Table 30 (Page 8 of 31). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2LCR	RELAY	PROVIDES POWER TO BRAKE RELAYS TO RELEASE BRAKES DURING LOWERING OPER- ATIONS, AND PROVIDES POWER TO START THE SEQUENCE TO ENERGIZE THE GENERATOR FIELD WINDING. N.O. CONTACT CLOSSES TO ENERGIZE LCR RUN WHICH ENERGIZES 2RUN.	a. N.C. CONTACT FAILS CLOSED	RELAY 2LCR WILL NOT BE LOCKED OUT. NO EFFECT ON HOISTING OPER- ATIONS.	NO EFFECT.	3
			a. COIL FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. BRAKES CANNOT BE RELEASED AND GENER- ATOR FIELD CANNOT BE ENERGIZED. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN b. CORROSION, BINDING MECHANISM c. 09FY12-006.039 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. RETURN THE MASTER CONTROLLER TO NEUTRAL OR PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS a. N.O. CONTACT FAILS CLOSED	RELAY 2RUN N.O. CONTACT WILL NOT CLOSE AND GENERATOR FIELD WILL NOT BE ENERGIZED. NO HOIST MOTOR TORQUE. LOAD WILL DESCEND, WITH REGENERATIVE BRAKING APPLIED, WHILE THE COMMAND, VIA THE MASTER CONTROL SWITCH, IS BEING GIVEN TO LOWER AND THE BRAKES ARE RELEASED. POWER WILL BE REMOVED FROM RELAY LCR RUN WHEN THE MASTER CONTROL SWITCH IS RETURNED TO CENTER AND SERIES RELAY CONTACT 2VR IS DEENERGIZED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM. NO EFFECT.	2 3

Table 30 (Page 9 of 31). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
		N.O. CONTACT, ARRANGED IN SERIES WITH 2VR, CLOSURES TO KEEP RELAY 2LCR ENERGIZED WHILE THE VOLTAGE IN THE DC DRIVE MOTOR CIRCUIT IS ABOVE A PREDETERMINED LIMIT. THIS PREVENTS THE BRAKES FROM SETTING, AFTER THE MASTER CONTROL SWITCH IS RETURNED TO NEUTRAL, WHILE THE MOTORS WIND DOWN.	a. N.O. CONTACT FAILS OPEN	BRAKES WILL SET IMMEDIATELY WHEN THE MASTER CONTROL SWITCH IS RETURNED TO NEUTRAL. POSSIBLE DAMAGE TO THE BRAKES.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	SERIES ARRANGEMENT OF 2VR N.O. CONTACT WILL REMOVE POWER FROM 2LCR AFTER THE VOLTAGE IN THE DC MOTOR CIRCUIT GOES BELOW THE PREDETERMINED LIMIT.	NO EFFECT.	3
		N.O. CONTACT CLOSURES TO ENERGIZE RELAY 2XR, WHICH RELEASES THE BRAKES, AND RELAY 2XR1, WHICH ENABLES THE GENERATOR FIELD DC INPUT CONTROLLER.	a. N.O. CONTACT FAILS OPEN	BRAKES WILL NOT BE RELEASED AND THE GENERATOR FIELD DC INPUT CONTROLLER WILL NOT BE ENABLED. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED b. WELDED CONTACTS, BINDING MECHANISM c. 09FY12-006.040 d. BRAKE SET LIGHT WILL NOT COME ON e. PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	BRAKE RELAYS WILL REMAIN ENERGIZED AND BRAKES WILL NOT SET WHEN HOIST MOTORS ARE COMMANDED TO STOP (IN NORMAL OPERATION). LOAD WILL DESCEND WITH REGENERATIVE BRAKING APPLIED. GENERATOR FIELD DC INPUT CONTROLLER WILL BE ENABLED BUT DEENERGIZED 2RUN CONTACT WILL PREVENT AN INPUT TO THE GENERATOR FIELD WINDING.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2

Table 30 (Page 10 of 31). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 12/13/17/18/19/28 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2HLS3	HIGH LEVEL LIMIT SWITCH	N.O. CONTACT CLOSURES TO ENABLE THE HAND BRAKE RELEASE SWITCH S1.	a. N.O. CONTACT FAILS OPEN	HAND BRAKE SWITCH S1 CANNOT RELEASE THE BRAKES. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	HAND BRAKE SWITCH S1 AND N.O. RELAY CONTACT 2XR, ARRANGED IN SERIES, WILL PREVENT THE BRAKES FROM BEING RELEASED INADVERT- ENTLY.	NO EFFECT.	3
		N.C. CONTACT OPENS TO DISABLE THE HOISTING PORTION OF THE CIRCUITRY.	a. N.C. CONTACT FAILS OPEN	RELAY 2HCR WILL REMAIN LOCKED OUT. UNABLE TO HOIST LOAD. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	RELAY 2HCR WILL NOT BE LOCKED OUT. NO EFFECT ON LOWERING OPER- ATIONS.	NO EFFECT.	3
		SHUTS DOWN THE HOIST AND SETS THE BRAKES IN THE EVENT THE UPPER LEVEL OF TRAVEL IS REACHED.	a. N.C. CONTACT FAILS OPEN	UNABLE TO OPERATE THE HOIST IN THE HOIST DIRECTION ONLY. IT WILL STILL OPERATE IN THE LOWER MODE. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	POSSIBLE DAMAGE TO THE WIRE ROPE. MULTIPLE FAILURE OR OPER- ATOR ERROR REQUIRED.	NO EFFECT.	3
2LLS-A	LOW LEVEL LIMIT SWITCH	SHUTS DOWN THE HOIST AND SETS THE BRAKES IN THE EVENT THE FIRST LOWER LIMIT OF TRAVEL IS REACHED.	a. N.C. CONTACT FAILS OPEN	UNABLE TO OPERATE THE HOIST IN THE LOWER DIRECTION ONLY. IT WILL STILL OPERATE IN THE HOIST MODE. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	POSSIBLE DAMAGE TO THE WIRE ROPE. MULTIPLE FAILURE OR OPER- ATOR ERROR REQUIRED.	NO EFFECT.	3

Table 30 (Page 11 of 31). **ELECTRICAL FMEA - AUXILIARY HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2LLS-B	LOW LEVEL LIMIT SWITCH	SHUTS DOWN THE HOIST AND SETS THE BRAKES IN THE EVENT THE SECOND LOWER LIMIT IS REACHED DURING FLOAT OPERATION.	a. N.C. CONTACT FAILS OPEN	UNABLE TO USE FLOAT MODE. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	POSSIBLE DAMAGE TO THE WIRE ROPE. MULTIPLE FAILURE OR OPER- ATOR ERROR REQUIRED.	NO EFFECT.	3
2HSTR	TIME DELAY RELAY	PROVIDES TIMED DELAY FOR ENERGIZING HIGH SPEED RELAY 2HS.	a. COIL FAILS OPEN	CONTACT REMAINS IN DE-ENERGIZED POSITION. UNABLE TO ENERGIZE HIGH SPEED RELAY AND ACHIEVE HIGH SPEED TRAVEL.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	UNABLE TO ENERGIZE HIGH SPEED RELAY AND ACHIEVE HIGH SPEED TRAVEL.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	SPEED SELECTOR SWITCH CONTACT, SS2-5, ARRANGED IN SERIES, WILL PREVENT THE HIGH SPEED RELAY FROM BEING ENERGIZED IF THE HIGH SPEED MODE IS NOT SELECTED.	NO EFFECT.	3
2HS	RELAY	ENERGIZES TO PROVIDE HIGH SPEED OPERATION OF THE HOIST.	a. COIL FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. LOSS OF HIGH SPEED RANGE.	NO EFFECT.	3
		N.O. CONTACT CLOSURES TO PROVIDE A REDUNDANT POWER PATH TO THE BRAKE RELAYS TO RELEASE THE BRAKES.	a. N.O. CONTACT FAILS OPEN	PARALLEL ARRANGED CONTACT OF RELAY 2XR WILL PROVIDE A POWER PATH TO RELEASE THE BRAKES.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	SERIES ARRANGED CONTACT OF RELAY 2XR WILL OPEN AND SET THE BRAKES.	NO EFFECT.	3

Table 30 (Page 12 of 31). **ELECTRICAL FMEA - AUXILIARY HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
HCR RUN	RELAY	N.C. CONTACT OPENS TO DEENERGIZE THE FIELD WEAKENING RELAY, 2FW, TO WEAKEN THE FIELD OF THE DC DRIVE MOTORS AND PUT THE HOIST IN THE HIGH SPEED MODE CONFIGURATION.	a. N.C. CONTACT FAILS OPEN b. CORROSION, BINDING MECHANISM c. 09FY12-006.105 d. SELSYN POSITION INDICATOR e. PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	THE N.C. CONTACT WILL OPEN, DEENERGIZING RELAY 2FW, WHICH PLACES RESISTORS 2FWR AND RESA IN SERIES WITH THE DC MOTOR FIELD WINDINGS. THE FIELD WILL BE WEAKENED BY THE REDUCTION OF CURRENT THROUGH THE WINDINGS. THE HOIST WILL BE IN THE HIGH SPEED MODE CONFIGURATION. THE HOIST SPEED WILL INCREASE TO APPROXIMATELY THREE TIMES THE COMMANDED SPEED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
		CONTROLS RELAY 2RUN FOR ENERGIZING THE GENERATOR FIELD WINDING DURING HOISTING OR FLOAT OPERATIONS.	a. N.C. CONTACT FAILS CLOSED	LOSS OF HIGH SPEED RANGE. NO EFFECT ON NORMAL OPERATIONS.	NO EFFECT.	3
			a. COIL FAILS OPEN b. CORROSION, FATIGUE c. 09FY12-006.041 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. RETURN THE MASTER CONTROLLER TO NEUTRAL OR PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	CONTACTS REMAIN IN DE-ENERGIZED POSITION. RELAY 2RUN N.O. CONTACT WILL NOT CLOSE AND THE GENERATOR FIELD WINDING WILL NOT BE ENERGIZED. NO HOIST MOTOR TORQUE. LOAD WILL DESCEND, WITH REGENERATIVE BRAKING APPLIED, WHILE THE COMMAND IS BEING GIVEN TO RAISE OR FLOAT AND THE BRAKES ARE RELEASED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2

Table 30 (Page 13 of 31). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 12/13/17/18/19/28 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
			a. N.O. CONTACT FAILS OPEN b. CORROSION, BINDING MECHANISM c. 09FY12-006.042 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. RETURN THE MASTER CONTROLLER TO NEUTRAL OR PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	RELAY 2RUN N.O. CONTACT WILL NOT CLOSE AND THE GENERATOR FIELD WINDING WILL NOT BE ENERGIZED. NO HOIST MOTOR TORQUE. LOAD WILL DESCEND, WITH REGENERATIVE BRAKING APPLIED, WHILE THE COMMAND IS GIVEN TO RAISE OR FLOAT AND THE BRAKES ARE RELEASED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. N.O. CONTACT FAILS CLOSED	RELAY 2RUN N.O. CONTACT WILL REMAIN CLOSED WHEN THE JOYSTICK IS RETURNED TO CENTER. THERE WILL BE NO INPUT TO THE GENERATOR FIELD WINDING BECAUSE THE GENERATOR FIELD DC INPUT CONTROLLER WILL BE DISABLED.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED b. WELDED CONTACTS, BINDING MECHANISM c. 09FY12-006.043 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. RETURN THE MASTER CONTROLLER TO NEUTRAL OR PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	RELAY 2RUN N.O. CONTACT WILL NOT CLOSE AND THE GENERATOR FIELD WINDING WILL NOT BE ENERGIZED. NO HOIST MOTOR TORQUE. LOAD WILL DESCEND, WITH REGENERATIVE BRAKING APPLIED, WHILE THE COMMAND IS GIVEN TO RAISE OR FLOAT AND THE BRAKES ARE RELEASED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2

Table 30 (Page 14 of 31). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
LCR RUN	RELAY	CONTROLS RELAY 2RUN FOR ENERGIZING THE GENERATOR FIELD WINDING DURING LOWERING OPERATIONS.	a. N.C. CONTACT FAILS OPEN	RELAY 2RUN N.O. CONTACT WILL DROP OUT (OPEN) BY GRAVITY AND/OR THE SPRING FORCE.	NO EFFECT.	3
			a. COIL FAILS OPEN b. CORROSION, FATIGUE c. 09FY12-006.044 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. RETURN THE MASTER CONTROLLER TO NEUTRAL OR PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	CONTACTS REMAIN IN DE-ENERGIZED POSITION. RELAY 2RUN N.O. CONTACT WILL NOT CLOSE AND THE GENERATOR FIELD WINDING WILL NOT BE ENERGIZED. NO HOIST MOTOR TORQUE. LOAD WILL DESCEND, WITH REGENERATIVE BRAKING APPLIED, WHEN THE COMMAND, VIA THE MASTER CONTROL SWITCH, IS GIVEN TO LOWER AND THE BRAKES ARE RELEASED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. N.O. CONTACT FAILS OPEN b. CORROSION, BINDING MECHANISM c. 09FY12-006.045 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. RETURN THE MASTER CONTROLLER TO NEUTRAL OR PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	RELAY 2RUN N.O. CONTACT WILL NOT CLOSE AND THE GENERATOR FIELD WINDING WILL NOT BE ENERGIZED. NO HOIST MOTOR TORQUE. LOAD WILL DESCEND, WITH REGENERATIVE BRAKING APPLIED, WHEN THE COMMAND, VIA THE MASTER CONTROL SWITCH IS GIVEN TO LOWER AND THE BRAKES ARE RELEASED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2

Table 30 (Page 15 of 31). **ELECTRICAL FMEA - AUXILIARY HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 12/13/17/18/19/28 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2XR	RELAY	ENERGIZES WHEN RELAY 2HCR OR 2LCR IS ENERGIZED BY THE MASTER CONTROLLER TO PROVIDE POWER TO THE BRAKE RELAYS 2BR & 2BR1 TO RELEASE THE BRAKES.	a. N.O. CONTACT FAILS CLOSED	RELAY 2RUN N.O. CONTACT WILL REMAIN CLOSED WHEN THE JOYSTICK IS RETURNED TO CENTER. THERE WILL BE NO INPUT TO THE GENERATOR FIELD WINDING BECAUSE THE GENERATOR FIELD DC INPUT CONTROLLER WILL BE DISABLED.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED b. WELDED CONTACTS, BINDING MECHANISM c. 09FY12-006.046 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. RETURN THE MASTER CONTROLLER TO NEUTRAL OR PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	RELAY 2RUN N.O. CONTACT WILL NOT CLOSE AND THE GENERATOR FIELD WINDING WILL NOT BE ENERGIZED. NO HOIST MOTOR TORQUE. LOAD WILL DESCEND, WITH REGENERATIVE BRAKING APPLIED, WHEN THE COMMAND, VIA THE MASTER CONTROL SWITCH, IS GIVEN TO LOWER AND THE BRAKES ARE RELEASED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. N.C. CONTACT FAILS OPEN	RELAY 2RUN N.O. CONTACT WILL DROP OUT (OPEN) BY GRAVITY AND/OR THE SPRING FORCE.	NO EFFECT.	3
			a. COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. UNABLE TO ENERGIZE BRAKE RELAYS AND RELEASE BRAKES. DELAY OF OPERATION.	NO EFFECT.	3

Table 30 (Page 16 of 31). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
		N.O. CONTACTS CLOSE TO ENERGIZE BRAKE RELAYS, 2BR AND 2BR1, WHEN THE MASTER CONTROLLER IS MOVED.	a. N.O. CONTACT FAILS OPEN a. N.O. CONTACT FAILS CLOSED b. WELDED CONTACTS, BINDING MECHANISM c. 09FY12-006.047 d. BRAKE SET LIGHT WILL NOT COME ON e. PRESS THE E-STOP BUTTON OR THE FOOT SWITCH S2. f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	UNABLE TO ENERGIZE BRAKE RELAY AND RELEASE BRAKES. DELAY OF OPERATION. BRAKE RELAYS WILL REMAIN ENERGIZED. BRAKES WILL NOT SET WHEN THE HOIST MOTORS ARE COMMANDED, VIA THE MASTER CONTROL SWITCH TO STOP. LOAD WILL DESCEND, WITH REGENERATIVE BRAKING APPLIED.	NO EFFECT. POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	3 2
		N.O. CONTACT CLOSURES TO PROVIDE A REDUNDANT POWER PATH, THROUGH SERIES ARRANGED CONTACT 2HS, TO RELEASE THE BRAKES IN THE HIGH SPEED MODE.	a. N.O. CONTACT FAILS OPEN a. N.O. CONTACT FAILS CLOSED	BRAKES WILL BE RELEASED THROUGH THE REDUNDANT 2XR CONTACT IN HIGH SPEED OPERATIONS. SERIES ARRANGED CONTACT 2HS WILL OPEN TO REMOVE POWER FROM THE BRAKE RELAYS.	NO EFFECT. NO EFFECT.	3 3

Table 30 (Page 17 of 31). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2FW	RELAY	THE RELAY ENERGIZES WHEN POWER IS APPLIED TO THE CRANE, CLOSING THE THREE NORMALLY OPEN (N.O.) CONTACTS. THE TWO SERIES ARRANGED CONTACTS BYPASS RESISTOR 2FWR TO ALLOW AN INCREASE IN CURRENT TO THE DC MOTOR FIELD WINDINGS TO STRENGTHEN THE FIELD. THE THIRD ENABLES, BUT DOES NOT ENERGIZE RELAY 2SRX. THE RELAY IS DEENERGIZED WHILE IN THE HIGH SPEED MODE, WHICH OPENS THE CONTACTS, TO PLACE RESISTORS 2FWR AND RESA IN SERIES WITH THE FIELD WINDINGS TO REDUCE THE CURRENT AND WEAKEN THE FIELD.	a. COIL FAILS OPEN b. CORROSION, FATIGUE c. 09FY12-006.106 d. SELSYN POSITION INDICATOR e. PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	THE N.O. CONTACTS WILL BE OPENED PLACING RESISTORS 2FWR AND RESA IN SERIES WITH THE DC MOTOR FIELD WINDINGS. THE FIELD WILL BE WEAKENED BY THE REDUCTION OF CURRENT THROUGH THE WINDINGS. THE HOIST WILL BE IN THE HIGH SPEED MODE CONFIGURATION. THE HOIST SPEED WILL INCREASE TO APPROXIMATELY THREE TIMES THE COMMANDED SPEED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. N.O. CONTACT FAILS OPEN (1 OF 3) b. CORROSION, BINDING MECHANISM c. 09FY12-006.107 d. SELSYN POSITION INDICATOR e. PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	THE N.O. CONTACTS (1 OF 3) WILL BE OPENED PLACING RESISTOR 2FWR OR RESA IN SERIES WITH THE DC MOTOR FIELD WINDINGS. THE FIELD WILL BE WEAKENED BY THE REDUCTION OF CURRENT THROUGH THE WINDINGS. THE HOIST WILL DESCEND AT A HIGHER RATE OF SPEED THAN EXPECTED. THE HOIST SPEED WILL INCREASE TO APPROXIMATELY TWO TIMES THE COMMANDED SPEED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2

Table 30 (Page 18 of 31). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 12/13/17/18/19/28 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2BR	RELAY, BRAKE	ENERGIZES TO PROVIDE POWER TO THE BRAKE SOLENOIDS TO RELEASE THE BRAKES.	a. COIL FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. BRAKES WILL NOT RELEASE. DELAY OF OPERATION.	NO EFFECT.	3
		TWO N.O. CONTACTS, ARRANGED IN SERIES WITH RELAY CONTACTS 2BR1 & 2BR2, CLOSE TO RELEASE THE BRAKES.	a. N.O. CONTACT FAILS OPEN	BRAKES WILL NOT RELEASE. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	REDUNDANT CONTACTS IN SERIES WILL OPEN TO SET THE BRAKES.	NO EFFECT.	3
		N.C. CONTACT OPENS TO EXTINGUISH THE "BRAKE SET" LIGHT INDICATOR, PL36, WHEN THE BRAKES ARE RELEASED.	a. N.C. CONTACT FAILS CLOSED	REDUNDANT CONTACT OF RELAY 2BR1 WILL OPEN TO SHUT OFF THE BRAKE SET LIGHT.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	BRAKE SET LIGHT WILL NOT COME ON WHEN BRAKES ARE SET. INDICATION PROBLEM ONLY. DELAY OF OPERATIONS.	NO EFFECT.	3
2BR1	RELAY	ENERGIZES TO PROVIDE POWER TO THE BRAKE SOLENOIDS TO RELEASE THE BRAKES.	a. COIL FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. BRAKES WILL NOT RELEASE. DELAY OF OPERATION.	NO EFFECT.	3
		TWO N.O. CONTACTS, ARRANGED IN SERIES WITH RELAY CONTACTS 2BR & 2BR2, CLOSE TO RELEASE THE BRAKES.	a. N.O. CONTACT FAILS OPEN	BRAKES WILL NOT RELEASE. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	REDUNDANT CONTACTS IN SERIES WILL OPEN TO SET THE BRAKES.	NO EFFECT.	3

Table 30 (Page 19 of 31). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2BTR	RELAY	N.C. CONTACT OPENS TO EXTINGUISH THE "BRAKE SET" LIGHT INDICATOR, PL36, WHEN THE BRAKES ARE RELEASED.	a. N.C. CONTACT FAILS CLOSED	REDUNDANT CONTACT OF RELAY 2BR WILL OPEN TO SHUT OFF THE BRAKE SET LIGHT.	NO EFFECT.	3
		ENERGIZES TO PROVIDE POWER TO RELAY 2BRX TO REDUCE THE CURRENT TO THE BRAKE SOLENOIDS AFTER SOLENOIDS ARE ENERGIZED.	a. N.C. CONTACT FAILS OPEN	BRAKE SET LIGHT WILL NOT COME ON WHEN BRAKES ARE SET. INDICATION PROBLEM ONLY: DELAY OF OPERATIONS.	NO EFFECT.	3
			a. COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. RELAY 2BRX WILL NOT BE ENERGIZED CAUSING POSSIBLE DAMAGE TO THE BRAKE SOLENOIDS OR TRIPPING OF BREAKER 2CCB3. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	RELAY 2BRX WILL NOT BE ENERGIZED CAUSING POSSIBLE DAMAGE TO THE BRAKE SOLENOIDS OR TRIPPING OF BREAKER 2CCB3. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	RELAY 2BRX WILL REMAIN ENERGIZED AND THE N.C CONTACT WILL REMAIN OPEN. BRAKE SOLENOIDS MAY NOT RECEIVE ENOUGH POWER TO RELEASE THE BRAKES. DELAY OF OPERATION.	NO EFFECT.	3

Table 30 (Page 20 of 31). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 12/13/17/18/19/28 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
S2	FOOT SWITCH	SWITCH CONTACT LOCATED BETWEEN RPOT AND THE GENERATOR FIELD DC INPUT CONTROLLER. THIS IS ARRANGED TO DISABLE THE RPOT INPUT WHEN OPERATING IN THE FLOAT MODE.	a. N.O. CONTACT FAILS OPEN b. CORROSION, MECHANICAL FAILURE c. 09FY12-006.054 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. RETURN THE MASTER CONTROLLER TO NEUTRAL OR PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	NO RPOT GENERATOR FIELD DC INPUT CONTROLLER EXCITATION VOLTAGE AND RESULTING OUTPUT TO GENERATOR FIELD WINDING. NO OUTPUT FROM GENERATOR. NO HOIST MOTOR TORQUE WHILE THE COMMAND IS BEING GIVEN, VIA THE MASTER CONTROL SWITCH, TO RAISE OR LOWER AND THE BRAKES ARE RELEASED. LOAD WILL DESCEND WITH REGENERATIVE BRAKING APPLIED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. N.O. CONTACT FAILS CLOSED	RPOT WILL REMAIN ENABLED. THIS HAS NO EFFECT ON THE FLOAT MODE OF OPERATION UNLESS THE MASTER CONTROLLER IS NOT RETURNED TO NEUTRAL. OPERATOR ERROR REQUIRED.	NO EFFECT.	3
		SWITCH CONTACT CLOSURES TO ENERGIZE THE FLOAT RELAY, FLT, WHICH IS USED TO DISABLE THE TIME DELAY RELAY, 2TDHC, TO INSURE THE OVERVOLTAGE RELAY, 2FOV, IS NOT BYPASSED WHEN THE FLOAT MODE IS SELECTED WHILE THE SPEED SELECTOR SWITCH, SS2, IS IN THE COARSE SPEED POSITION.	a. N.O. CONTACT FAILS OPEN	LOSS OF ABILITY TO DISABLE THE TIME DELAY RELAY WHEN OPERATING IN THE FLOAT MODE. THIS WOULD ALLOW THE TIME DELAY RELAY TO BYPASS THE OVERVOLTAGE RELAY IF THE FLOAT MODE IS SELECTED WHILE THE SPEED SELECTOR SWITCH IS IN THE COARSE SPEED POSITION. MULTIPLE FAILURE REQUIRED TO RESULT IN DAMAGE TO A VEHICLE SYSTEM.	NO EFFECT.	3

Table 30 (Page 21 of 31). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 12/13/17/18/19/28 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
		CONTACT CLOSURES TO ENERGIZE RELAY 2HCR TO OPERATE THE CRANE IN THE FLOAT MODE.	a. N.O. CONTACT FAILS CLOSED a. N.O. CONTACT FAILS OPEN a. N.O. CONTACT FAILS CLOSED b. CORROSION, MECHANICAL FAILURE c. 09FY12-006.108 d. INDICATION OF MOVEMENT ON THE CONSOLE SELSYN e. PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	THE FLOAT RELAY WILL REMAIN ENERGIZED AND THE OVERVOLTAGE RELAY WOULD NOT BE BYPASSED IN THE COARSE SPEED MODE. IF THE HOIST IS OPERATED IN COARSE SPEED, THE M-G SET WILL BE SHUT DOWN BY THE OVERVOLTAGE RELAY AT 115% OF THE FULL FINE OUTPUT. UNABLE TO USE FLOAT CONTROLS FOR FLOATING THE LOAD. DELAY OF OPERATION. RELAY 2HCR WILL REMAIN ENERGIZED. THIS WILL ENERGIZE THE BRAKE RELAYS, 2BR & 2BR1, AND RELEASE THE BRAKES WHILE NO COMMAND IS BEING INITIATED TO MOVE THE LOAD. LOAD WILL DESCEND WITH REGENERATIVE BRAKING APPLIED.	NO EFFECT. NO EFFECT. POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	3 3 2
		CONTACT OPENS TO ENABLE THE OPERATOR TO CONTROL THE BRAKES WITH BRAKE SWITCH S1 FOR FLOAT MODE OPERATIONS.	a. N.C. CONTACT FAILS OPEN	THE BRAKES CANNOT BE RELEASED WITH THE NORMAL MOVEMENT OF THE MASTER CONTROLLER, 2MC. THE BRAKES WILL REMAIN SET. DELAY OF OPERATION.	NO EFFECT.	3

Table 30 (Page 22 of 31). **ELECTRICAL FMEA - AUXILIARY HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 12/13/17/18/19/28 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
S1	BRAKE SWITCH	PROVIDES OPERATOR CONTROL OF POWER TO BRAKE RELAYS, 2BR AND 2BR1, TO RELEASE OR SET THE BRAKES WHEN REQUIRED DURING FLOAT OPERATIONS.	a. N.C. CONTACT FAILS CLOSED b. CORROSION, MECHAN- ICAL FAILURE c. 09FY12-006.109 d. INDICATION OF MOVE- MENT ON THE CONSOLE SELSYN e. DISENGAGE FOOT SWITCH S2 OR PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	THE BRAKES WILL BE RELEASED WHEN THE FOOT SWITCH IS ENGAGED. LOAD WILL DESCEND WITH REGENER- ATIVE BRAKING APPLIED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. FAILS OPEN	UNABLE TO RELEASE BRAKES FOR FLOATING OPERATIONS. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAILS CLOSED	BRAKE RELAYS WILL REMAIN ENER- GIZED AND BRAKES WILL NOT SET WHEN OPERATOR RELEASES BRAKE HANDLE DURING FLOATING OPER- ATIONS. THE LOAD WILL STILL BE CONTROLLED WITH THE FLOAT POTENTIOMETER, AND THE BRAKES CAN BE SET BY RELEASING THE FOOT SWITCH S2. DELAY OF OPERATION.	NO EFFECT.	3
4RECT	RECTIFIER, BRIDGE	CONVERTS 120V AC INPUT TO DC OUTPUT FOR ENERGIZING RELAY 2RUN FOR CONTROL- LING CURRENT TO THE GEN- ERATOR FIELD WINDING.	a. DIODE FAILS OPEN	NO DC OUTPUT FROM 4RECT WILL DEENERGIZE DC RELAY 4DC, WHICH WILL SHUT DOWN THE M-G SET. BRAKES WILL SET. DELAY OF OPER- ATIONS.	NO EFFECT.	3

Table 30 (Page 23 of 31). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 12/13/17/18/19/28 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
4DC	RELAY	ENERGIZES TO INSURE THE BRIDGE RECTIFIER, 4RECT, IS SUPPLYING THE PROPER OUTPUT. THIS WILL SHUT DOWN THE M-G SET IF 4RECT OUTPUT IS LOST.	a. DIODE FAILS SHORT	INCREASED CURRENT TO THE RELAY COILS RESULTING IN THE COILS FAILING OPEN. RELAY 4DC COIL FAILING OPEN SHUTS DOWN THE M-G SET AND SETS THE BRAKES. 2RUN COIL FAILING OPEN RESULTS IN THE N.O. CONTACT DROPPING OUT (OPEN) BY GRAVITY AND/OR THE SPRING FORCE. DELAY OF OPERATION.	NO EFFECT.	3
			a. COIL FAILS OPEN	RELAY CONTACTS WILL REMAIN IN THE DEENERGIZED POSITION. M-G SET CANNOT BE STARTED. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	M-G SET CANNOT BE STARTED. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	LOSS OF M-G SET SHUT DOWN CAPABILITY IF 4RECT OUTPUT IS LOST. MULTIPLE FAILURE REQUIRED.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	INDICATION OF THE LOSS OF 4RECT OUTPUT WILL NOT COME ON. INDICATION PROBLEM ONLY.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	INDICATION OF THE LOSS OF 4RECT OUTPUT WILL REMAIN ON CONTINUOUSLY. INDICATION PROBLEM ONLY. DELAY OF OPERATIONS.	NO EFFECT.	3

Table 30 (Page 24 of 31). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2RUN	RELAY	N.O. CONTACT CLOSURES TO ALLOW INPUT CURRENT FROM THE GENERATOR FIELD DC INPUT CONTROLLER TO THE M-G SET GENERATOR FIELD WINDING TO MOVE THE DC DRIVE MOTORS. N.C. CONTACT ALLOWS RESIDUAL CURRENT IN THE GENERATOR TO DIMINISH AFTER THE DRIVE MOTION IS COMPLETED.	a. "PULL IN" COIL FAILS OPEN b. CORROSION, FATIGUE c. 09FY12-006 049 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. RETURN THE MASTER CONTROLLER TO NEUTRAL OR PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	N.O. CONTACT REMAINS IN DE-ENERGIZED POSITION. GENERATOR FIELD WINDING WILL NOT BE ENERGIZED. NO HOIST MOTOR TORQUE. LOAD WILL DESCEND, WITH REGENERATIVE BRAKING APPLIED, WHEN THE COMMAND IS GIVEN, VIA THE MASTER CONTROL SWITCH, TO RAISE OR LOWER AND THE BRAKES ARE RELEASED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. "DROP OUT" COIL FAILS OPEN.	THE N.O. CONTACT WILL DROP OUT (OPEN) BY GRAVITY AND/OR THE SPRING FORCE.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN/N.C. CONTACT FAILS CLOSED b. CORROSION, BINDING MECHANISM c. 09FY12-006 050 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. RETURN THE MASTER CONTROLLER TO NEUTRAL OR PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	GENERATOR FIELD WINDING WILL NOT BE ENERGIZED. NO HOIST MOTOR TORQUE. LOAD WILL DESCEND, WITH REGENERATIVE BRAKING APPLIED, WHEN THE COMMAND, VIA THE MASTER CONTROL SWITCH, IS GIVEN TO RAISE OR LOWER AND THE BRAKES ARE RELEASED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2

Table 30 (Page 25 of 31). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 12/13/17/18/19/28 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2RS14	RESISTOR	PROVIDES A CURRENT LIMITER FOR THE RESIDUAL CURRENT IN THE GENERATOR AFTER THE DRIVE MOTION IS COMPLETED.	a. N.O. CONTACT FAILS CLOSED/N.C. CONTACT FAILS OPEN	N.O. CONTACT WILL REMAIN CLOSED WHEN THE JOYSTICK IS RETURNED TO CENTER. THERE WILL BE NO INPUT TO THE GENERATOR FIELD WINDING BECAUSE THE GENERATOR FIELD DC INPUT CONTROLLER WILL BE DISABLED.	NO EFFECT.	3
2ACR	RELAY	PROVIDES POWER TO ACTIVATE MOTOR OVERHEATING ALARM.	a. FAILS OPEN	THE RESIDUAL CURRENT IN THE GENERATOR WILL NOT BE DIMINISHED. NO EFFECT ON NORMAL OPERATIONS.	NO EFFECT.	3
			a. COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. OVERHEATING ALARM WILL NOT SOUND. NO EFFECT ON INDICATOR LIGHT.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	OVERHEATING ALARM WILL NOT SOUND NO EFFECT ON INDICATOR LIGHT.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	OVERHEATING ALARM WILL SOUND INADVERTENTLY. DELAY OF OPERATION.	NO EFFECT.	3
PL16	INDICATION LAMP	PROVIDES INDICATION THAT HOIST MOTOR #1 IS OVERHEATING.	a. FAILS OPEN	NO INDICATION FOR MOTOR OVERHEATING FROM LIGHT. ALARM WILL SOUND.	NO EFFECT.	3
PL17	INDICATION LAMP	PROVIDES INDICATION THAT HOIST MOTOR #2 IS OVERHEATING.	a. FAILS OPEN	NO INDICATION FOR MOTOR OVERHEATING FROM LIGHT. ALARM WILL SOUND.	NO EFFECT.	3
PL18	INDICATION LAMP	PROVIDES INDICATION THAT HOIST BLOWER #1 IS OVERHEATING.	a. FAILS OPEN	NO INDICATION FOR BLOWER MOTOR OVERHEATING FROM LIGHT.	NO EFFECT.	3

Table 30 (Page 26 of 31). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 12/13/17/18/19/28 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
PL19	INDICATION LAMP	PROVIDES INDICATION THAT HOIST BLOWER #2 IS OVER- HEATING.	a. FAILS OPEN	NO INDICATION FOR BLOWER MOTOR OVERHEATING FROM LIGHT.	NO EFFECT.	3
2-OLR1, 2-OLR2	RELAY	RELAYS ENERGIZE TO ENABLE THE BLOWER MOTOR START RELAY 2MB. PRO- VIDES CAPABILITY TO SHUT DOWN BOTH BLOWER MOTORS AND LIGHT BLOWER MOTOR OVERHEATING INDI- CATOR LIGHTS WHEN DEEN- ERGIZED BY ONE OF THE BLOWER MOTOR OVERLOADS.	a. COIL FAILS OPEN	CONTACTS REMAIN IN DEENERGIZED POSITION. THE BLOWER MOTORS WILL NOT START. BLOWER MOTOR OVERHEATING INDICATION LIGHT WILL REMAIN ON. DELAY OF OPERA- TION.	NO EFFECT	3
			a. N.C. CONTACT FAILS CLOSED	BLOWER MOTOR OVERHEATING INDI- CATION LIGHT WILL REMAIN ON. DELAY OF OPERATION.	NO EFFECT	3
			a. N.C. CONTACT FAILS OPEN	BLOWER MOTOR OVERHEATING INDI- CATION LIGHT WILL NOT COME ON IF AN OVERHEAT OCCURS. THE BLOWER MOTOR WILL BE SHUT DOWN BY THE N.O. CONTACT. THE HOIST MOTOR WINDING TEMPERATURE SENSOR WILL SHUT DOWN THE HOIST M-G SET IF NECESSARY.	NO EFFECT	3
			a. N.O. CONTACT FAILS OPEN	THE BLOWER MOTORS WILL NOT START. POSSIBLE DAMAGE TO THE DC DRIVE MOTORS. THE HOIST MOTOR WINDING TEMPERATURE SENSOR WILL SHUT DOWN THE HOIST M-G SET IF NECESSARY.	NO EFFECT	3
			a. N.O. CONTACT FAILS CLOSED	SERIES ARRANGED CONTACTS WILL OPEN TO SHUT DOWN THE BLOWER MOTORS.	NO EFFECT	3

Table 30 (Page 27 of 31). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 12/13/17/18/19/28 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
D3	DIODE	PREVENTS HOIST MOTOR #1 OVERHEATING INDICATOR FROM COMING ON WHILE ALARM RELAY, 2ACR, IS ENERGIZED WHEN HOIST MOTOR #2 OVERHEATS.	a. FAILS OPEN	ALARM WILL NOT SOUND WHEN MOTOR #1 OVERHEATS. INDICATION LIGHT WILL SIGNAL OPERATOR OF OVERHEAT CONDITION.	NO EFFECT.	3
			a. FAILS SHORT	HOIST MOTOR #1 OVERHEAT INDICATOR WILL COME ON WHEN MOTOR #2 OVERHEATS. ALARM MAY NOT SOUND.	NO EFFECT.	3
D4	DIODE	PREVENTS HOIST MOTOR #2 OVERHEATING INDICATOR FROM COMING ON WHILE ALARM RELAY, 2ACR, IS ENERGIZED WHEN HOIST MOTOR #1 OVERHEATS.	a. FAILS OPEN	ALARM WILL NOT SOUND WHEN MOTOR #2 OVERHEATS. INDICATION LIGHT WILL SIGNAL OPERATOR OF OVERHEAT CONDITION.	NO EFFECT.	3
			a. FAILS SHORT	HOIST MOTOR #2 OVERHEAT INDICATOR WILL COME ON WHEN MOTOR #1 OVERHEATS. ALARM MAY NOT SOUND.	NO EFFECT.	3
2K1	RELAY	OVERHEATING TEMPERATURE SENSING RELAY IS ACTUATED WHEN A THERMISTOR IN THE WINDINGS OF HOIST MOTOR #1 REACHES A PRE-DETERMINED TEMPERATURE. THE CONTACTS CLOSE TO SOUND ALARM AND TURN ON OVERHEATING INDICATOR LIGHT.	a. THERMISTOR COIL FAILS OPEN	LOSS OF MOTOR OVERHEATING DETECTION CIRCUIT. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 2K3 TO SHUT DOWN M-G SET IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3
			a. THERMISTOR COIL FAILS SHORT	RELAY MAY BE ENERGIZED CAUSING ALARM TO SOUND AND OVERHEATING INDICATOR LIGHT TO COME ON. DELAY OF OPERATION.	NO EFFECT.	3

Table 30 (Page 28 of 31). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 12/13/17/18/19/28 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2K2	RELAY	OVERHEATING TEMPERATURE SENSING RELAY IS ACTUATED WHEN A THERMISTOR IN THE WINDINGS OF HOIST MOTOR #2 REACHES A PRE-DETERMINED TEMPERATURE. THE CONTACTS CLOSE TO SOUND ALARM AND TURN ON OVERHEATING INDICATOR LIGHT.	a. RELAY COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. ALARM WILL NOT SOUND AND OVERHEATING INDICATOR LIGHT WILL NOT LIGHT. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 2K3 TO SHUT DOWN M-G SET IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	ALARM WILL NOT SOUND AND OVERHEATING INDICATOR LIGHT WILL NOT LIGHT IF A MOTOR OVERHEAT OCCURS. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 2K3 TO SHUT DOWN M-G SET IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	OVERHEAT ALARM AND LIGHT WILL BE ON. DELAY OF OPERATION.	NO EFFECT.	3
			a. THERMISTOR COIL FAILS OPEN	LOSS OF MOTOR OVERHEATING DETECTION CIRCUIT. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 2K4 TO SHUT DOWN M-G SET IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3
			a. THERMISTOR COIL FAILS SHORT	RELAY MAY BE ENERGIZED CAUSING ALARM TO SOUND AND OVERHEATING INDICATOR LIGHT TO COME ON. DELAY OF OPERATION.	NO EFFECT.	3

Table 30 (Page 29 of 31). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2K3	RELAY	OVERHEATING TEMPERATURE SENSING RELAY IS ACTUATED WHEN A THERMISTOR IN THE WINDINGS OF HOIST MOTOR #1 REACHES A PRE-DETERMINED TEMPERATURE. THE CONTACTS OPEN TO SHUT DOWN THE M-G SET.	a. RELAY COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. ALARM WILL NOT SOUND AND OVERHEATING INDICATOR LIGHT WILL NOT LIGHT. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 2K4 TO SHUT DOWN M-G SET IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	ALARM WILL NOT SOUND AND OVERHEATING INDICATOR LIGHT WILL NOT LIGHT IF A MOTOR OVERHEAT OCCURS. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 2K4 TO SHUT DOWN M-G SET IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	OVERHEAT ALARM AND LIGHT WILL BE ON. DELAY OF OPERATION.	NO EFFECT.	3
			a. THERMISTOR COIL FAILS OPEN	LOSS OF MOTOR OVERHEATING DETECTION CIRCUIT. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 2K1 TO SOUND ALARM AND LIGHT OVERHEATING INDICATOR LIGHT IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3
			a. THERMISTOR COIL FAILS SHORT	RELAY MAY BE ENERGIZED CAUSING M-G SET TO SHUT DOWN. DELAY OF OPERATION.	NO EFFECT.	3

Table 30 (Page 30 of 31). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 12/13/17/18/19/28 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2K4	RELAY	OVERHEATING TEMPERATURE SENSING RELAY IS ACTUATED WHEN A THERMISTOR IN THE WINDINGS OF HOIST MOTOR #2 REACHES A PRE-DETERMINED TEMPERATURE. THE CONTACTS OPEN TO SHUT DOWN THE M-G SET.	a. RELAY COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 2K1 TO SOUND ALARM AND LIGHT OVERHEATING INDICATOR LIGHT IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	M-G SET WILL NOT SHUT DOWN IF A MOTOR OVERHEAT OCCURS. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 2K1 TO SOUND ALARM AND LIGHT OVERHEATING INDICATOR LIGHT IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	M-G SET WILL NOT START. DELAY OF OPERATION.	NO EFFECT.	3
			a. THERMISTOR COIL FAILS OPEN	LOSS OF MOTOR OVERHEATING DETECTION CIRCUIT. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 2K2 TO SOUND ALARM AND LIGHT OVERHEATING INDICATOR LIGHT IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3
			a. THERMISTOR COIL FAILS SHORT	RELAY MAY BE ENERGIZED CAUSING M-G SET TO SHUT DOWN. DELAY OF OPERATION.	NO EFFECT.	3
			a. RELAY COIL FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 2K2 TO SOUND ALARM AND LIGHT OVERHEATING INDICATOR LIGHT IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3

Table 30 (Page 31 of 31). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 12/13/17/18/19/28 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2F2	FUSE	PROTECTS FAN MOTORS, M33 & M34, FROM CURRENT OVERLOAD.	a. N.C. CONTACT FAILS CLOSED	M-G SET WILL NOT SHUT DOWN IF A MOTOR OVERHEAT OCCURS. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 2K2 TO SOUND ALARM AND LIGHT OVERHEATING INDICATOR LIGHT IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	M-G SET WILL NOT START. DELAY OF OPERATION.	NO EFFECT.	3
			a. PREMATURE ACTUATION	FAN MOTORS, M33 & M34, WILL STOP. LOSS OF AIRFLOW IN THE RELAY CABINET. NO EFFECT ON CRANE OPERATION.	NO EFFECT.	3
			a. FAILS TO ACTUATE	POSSIBLE DAMAGE TO THE FAN MOTORS, M33 & M34. MULTIPLE FAILURE REQUIRED.	NO EFFECT.	3
M33, M34	FAN MOTORS	PROVIDES COOLING FOR THE DRIVE CONTROL RELAY CABINETS.	a. FAILS TO OPERATE	LOSS OF AIRFLOW IN THE RELAY CABINET. NO EFFECT ON CRANE OPERATION.	NO EFFECT.	3

Table 31 (Page 1 of 5). **ELECTRICAL FMEA - AUXILIARY HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 19 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 16, 18 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
RPOT	POTENTIO- METER	REFERENCE POTENTIOMETER CONNECTED TO THE MASTER CONTROL SWITCH (JOYSTICK), 2MC, TO REGU- LATE THE INPUT EXCITATION VOLTAGE TO THE GENER- ATOR FIELD DC INPUT CON- TROLLER, 2FC, AND THE RESULTING OUTPUT TO THE GENERATOR FIELD WINDING FOR HOIST SPEED CONTROL DURING RAISING OR LOW- ERING OPERATIONS.	a. FAIL OPEN b. CORROSION, FATIGUE c. 09FY12-006.053 d. CURRENT INDICATION ON CONSOLE AMMETER e. BRING THE MASTER CONTROLLER TO NEUTRAL OR PRESS E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	IF THE FAILURE OCCURS ON THE WIPER ARM IT WOULD RESULT IN NO GENERATOR FIELD DC INPUT CON- TROLLER EXCITATION VOLTAGE. NO GENERATOR FIELD WINDING VOLTAGE. NO OUTPUT FROM GENERATOR. NO HOIST MOTOR TORQUE WHILE THE COMMAND IS BEING GIVEN, VIA THE MASTER CONTROL SWITCH, TO RAISE OR LOWER AND THE BRAKES ARE RELEASED. LOAD WILL DESCEND WITH REGENERATIVE BRAKING APPLIED. OR IF THE FAILURE OCCURS ON THE RESISTIVE ELEMENT, IT WOULD RESULT IN A LOSS OF THE PARALLEL RESISTANCE BRANCH AND CREATE A LARGER INPUT INTO THE GENERATOR FIELD DC INPUT CONTROLLER WHICH WILL CAUSE AN INCREASING SPEED OF THE DC MOTORS CONTROLLING THE HOIST.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
2RR4A, 2RR4B	RESISTOR	PROVIDES A VOLTAGE DIVIDER FOR THE +/- 6VDC POWER SOURCE TO RPOT, FOR INPUT TO THE GENER- ATOR FIELD DC INPUT CON- TROLLER, 2FC, TO ALLOW FOR HOIST OPERATION IN THE FINE SPEED MODE.	a. FAILS OPEN b. CONTAMINATION, COR- ROSION, FATIGUE c. 09FY12-006.078 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. BRING THE MASTER CONTROLLER TO NEUTRAL OR PRESS E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	NO GENERATOR FIELD DC INPUT CON- TROLLER EXCITATION VOLTAGE IN THE FINE SPEED MODE OF OPERA- TION. NO GENERATOR FIELD WINDING VOLTAGE. NO OUTPUT FROM GENER- ATOR. NO HOIST MOTOR TORQUE WHILE THE COMMAND IS BEING GIVEN, VIA THE MASTER CONTROL SWITCH, TO RAISE OR LOWER THE LOAD WHILE THE BRAKES ARE RELEASED. LOAD WILL DESCEND WITH REGENERATIVE BRAKING APPLIED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2

Table 31 (Page 2 of 5). **ELECTRICAL FMEA - AUXILIARY HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 16, 18 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
FPOT	POTENTIO-METER	CONTROLS THE INPUT EXCITATION VOLTAGE TO THE GENERATOR FIELD DC INPUT CONTROLLER, 2FC, AND THE RESULTING OUTPUT TO GENERATOR FIELD WINDING FOR HOIST CONTROL DURING FLOAT OPERATIONS.	a. FAIL OPEN b. CORROSION, FATIGUE c. 09FY12-006.056 d. CURRENT INDICATION ON CONSOLE AMMETER e. RELEASE BRAKE SWITCH f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	NO GENERATOR FIELD DC INPUT CONTROLLER EXCITATION VOLTAGE WHILE IN THE FLOAT MODE. NO GENERATOR FIELD WINDING VOLTAGE. NO OUTPUT FROM GENERATOR. NO HOIST MOTOR TORQUE WHILE THE COMMAND IS BEING GIVEN TO FLOAT AND THE BRAKES ARE RELEASED, VIA THE BRAKE SWITCH. LOAD WILL DESCEND WITH REGENERATIVE BRAKING APPLIED. OR IF THE FAILURE OCCURS ON THE RESISTIVE ELEMENT, IT WOULD RESULT IN A LOSS OF THE PARALLEL RESISTANCE BRANCH AND CREATE A LARGER INPUT INTO THE GENERATOR FIELD DC INPUT CONTROLLER WHICH WILL CAUSE AN INCREASED INPUT TO THE DC MOTORS CONTROLLING THE HOIST. THIS COULD RESULT IN AN INADVERTENT MOVEMENT OF THE LOAD.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
2RR7	RESISTOR	PROVIDES A VOLTAGE DIVIDER FOR THE INPUT FROM FPOT TO THE GENERATOR FIELD DC INPUT CONTROLLER, 2FC, TO ALLOW FOR HOIST OPERATION IN THE FLOAT MODE.	a. FAILS OPEN b. CONTAMINATION, CORROSION, FATIGUE c. 09FY12-006.079 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. RELEASE BRAKE SWITCH f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	NO GENERATOR FIELD DC INPUT CONTROLLER EXCITATION VOLTAGE IN THE FLOAT MODE OF OPERATION. NO GENERATOR FIELD WINDING VOLTAGE. NO OUTPUT FROM GENERATOR. NO HOIST MOTOR TORQUE WHILE THE COMMAND IS BEING GIVEN TO FLOAT AND THE BRAKES ARE RELEASED, VIA THE BRAKE SWITCH. LOAD WILL DESCEND WITH REGENERATIVE BRAKING APPLIED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
7AM	AMMETER	PROVIDES INDICATION AT THE CONSOLE OF THE CURRENT TO THE HOIST MOTORS.	a. FAILS OPEN	LOSS OF INDICATION OF OPERATOR OF MOTOR CURRENT. DELAY OF OPERATION.	NO EFFECT.	3

Table 31 (Page 3 of 5). **ELECTRICAL FMEA - AUXILIARY HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 16, 18 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
M2	HOIST METER RELAY	CONTROLS RELAY K9 TO SCALE CURRENT READING ON THE CONSOLE AMMETER BY A FACTOR OF 10 WHEN THE HOIST MOTORS CURRENT REACHES 20 AMPS. ALSO CONTROLS CONSOLE LIGHT PL34 TO INDICATE TO OPER- ATOR WHEN CURRENT READING IS SCALED.	a. COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. CURRENT READING ON CONSOLE AMMETER WILL NOT BE SCALED BY A FACTOR OF 10. DELAY OF OPERATION.	NO EFFECT.	3
			a. HIGH/LOW LIMIT NO. 1 N.O. CONTACT FAILS OPEN	PL34 WILL NOT LIGHT WHEN CURRENT TO HOIST MOTORS REACHES 20 AMPS TO INDICATE TO OPERATOR THAT THE CONSOLE AMMETER READING IS NOW SCALED. DELAY OF OPERATION.	NO EFFECT.	3
			a. HIGH/LOW LIMIT NO. 1 N.O. CONTACT FAILS CLOSED	INDICATOR LIGHT, PL34 WILL BE LIT FOR ENTIRE RANGE OF CURRENT TO HOIST MOTORS. DELAY OF OPERA- TION.	NO EFFECT.	
			a. HIGH/LOW LIMIT NO. 2 N.C. CONTACT FAILS CLOSED	RELAY K9 WILL NOT DE-ENERGIZE TO BRING RESISTOR R2 INTO USE TO SCALE THE CURRENT READING ON THE CONSOLE AMMETER. DELAY OF OPERATION.	NO EFFECT.	3

Table 31 (Page 4 of 5). **ELECTRICAL FMEA - AUXILIARY HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 16, 18 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
K9	RELAY	ENERGIZED WHEN HOIST MOTORS ARE DRAWING LESS THAN 20 AMPS. CONTACTS ARE CLOSED TO ALLOW THE CONSOLE AMMETER TO DISPLAY ACTUAL CURRENT. DE-ENERGIZED WHEN CURRENT REACHES 20 AMPS TO SCALE THE CURRENT READING ON THE CONSOLE AMMETER BY A FACTOR OF 10.	a. HIGH/LOW LIMIT NO. 2 N.C. CONTACT FAILS OPEN b. CORROSION, BINDING MECHANISM c. 09FY12-006.060 d. ABNORMAL MOVEMENT OF LOAD e. PRESS E-STOP OR RELEASE BRAKE SWITCH f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	RELAY K9 WILL NOT BE ENERGIZED AND THE CURRENT READING ON THE CONSOLE AMMETER WILL BE SCALED WITHOUT INDICATION FROM CONSOLE LIGHT PL34. THIS COULD LEAD TO AN OPERATOR GIVING AN ERRONEOUS INPUT DURING FLOAT OPERATIONS RESULTING IN ADVERTENT MOVEMENT OF THE LOAD.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. COIL FAILS OPEN b. CORROSION, BINDING MECHANISM c. 09FY12-006.061 d. ABNORMAL MOVEMENT OF LOAD e. PRESS E-STOP OR RELEASE BRAKE SWITCH f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	CONTACTS REMAIN IN DE-ENERGIZED POSITION. THE CURRENT READING ON THE CONSOLE AMMETER WILL BE SCALED WITHOUT INDICATION FROM CONSOLE LIGHT PL34. THIS COULD LEAD TO AN OPERATOR GIVING AN ERRONEOUS INPUT DURING FLOAT OPERATIONS RESULTING IN AN INADVERTENT MOVEMENT OF THE LOAD.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. N.O CONTACT FAILS OPEN b. CORROSION, BINDING MECHANISM c. 09FY12-006.062 d. ABNORMAL MOVEMENT OF LOAD e. PRESS E-STOP OR RELEASE BRAKE SWITCH f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	THE CURRENT READING ON THE CONSOLE AMMETER WILL BE SCALED WITHOUT INDICATION FROM CONSOLE LIGHT P34. THIS COULD LEAD TO AN OPERATOR GIVING AN ERRONEOUS INPUT DURING FLOAT OPERATIONS RESULTING IN AN INADVERTENT MOVEMENT OF THE LOAD.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2

Table 31 (Page 5 of 5). **ELECTRICAL FMEA - AUXILIARY HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 19 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 16, 18 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
R2	RESISTOR, VARIABLE	WHEN CURRENT IN THE HOIST MOTORS REACHES 20 AMPS, THIS RESISTOR IS USED FOR CURRENT LIMITING TO SCALE THE CONSOLE AMMETER CURRENT READING BY A FACTOR OF 10.	a. N.O. CONTACT FAILS CLOSED	RESISTOR R2 WILL NOT BE BROUGHT INTO USE TO SCALE THE CURRENT READING ON THE CONSOLE AMMETER. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAILS OPEN	NO CURRENT READING ON CONSOLE AMMETER FOR HIGH CURRENT OPER- ATIONS. DELAY OF OPERATION.	NO EFFECT.	3
PL34	INDICATOR LIGHT	LIGHTS WHEN CURRENT TO HOIST MOTORS REACHES 20 AMPS AND INDICATES TO THE OPERATOR THAT THE CONSOLE AMMETER READING IS NOW SCALED BY A FACTOR OF 10.	a. FAIL OPEN	FAILS TO INDICATE TO OPERATOR THAT THE READING ON THE CONSOLE AMMETER IS SCALED BY A FACTOR OF 10. OPERATOR WILL SEE CHANGE WHEN CURRENT REACHES 20A. DELAY OF OPERATION.	NO EFFECT.	3
2-OLA	RELAY, OVERLOAD (INSTANTA- NEOUS)	SHUTS DOWN THE HOIST M-G SET IF THE HOIST MOTORS EXPERIENCE AN OVERLOAD. (NOTE GROUND RULE e).	a. N.C. CONTACT FAILS CLOSED	M-G SET WILL NOT SHUT DOWN IF AN OVERLOAD CONDITION OCCURS. POS- SIBLE DAMAGE TO THE DC DRIVE MOTORS. MULTIPLE FAILURE REQUIRED.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	M-G SET WILL NOT RUN. DELAY OF OPERATION.	NO EFFECT.	3

Table 32. ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15. Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2VR	RELAY, VOLTAGE	MONITORS VOLTAGE IN THE HOIST MOTOR LOOP AND PROVIDES LATCHING TO KEEP RELAYS 2HCR OR 2LCR ENERGIZED, AFTER MASTER CONTROL SWITCH IS RETURNED TO THE NEUTRAL POSITION. THIS PREVENTS THE BRAKES FROM SETTING WHILE VOLTAGE IN THE MOTOR LOOP IS ABOVE A PREDETERMINED LIMIT.	a. COIL FAILS OPEN	CONTACT REMAINS IN DE-ENERGIZED POSITION. BRAKES WILL SET IMME- DIATELY WHEN MASTER CONTROL SWITCH IS MOVED TO STOP POSITION. POSSIBLE DAMAGE TO THE BRAKES.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	BRAKES WILL SET IMMEDIATELY WHEN MASTER CONTROL SWITCH IS MOVED TO STOP POSITION. POS- SIBLE DAMAGE TO THE BRAKES.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED b. WELDED CONTACT, BINDING MECHANISM c. 09FY12-006.064 d. BRAKE SET LIGHT WILL NOT COME ON e. PRESS E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	BRAKE RELAYS WILL REMAIN ENER- GIZED AND BRAKES WILL NOT SET WHEN THE HOIST MOTORS ARE COM- MANDED, VIA THE MASTER CONTROL SWITCH, TO STOP. LOAD WILL DESCEND WITH REGENERATIVE BRAKING APPLIED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2

Table 33 (Page 1 of 7). **ELECTRICAL FMEA - AUXILIARY HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 17/18/19 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2KR	RELAY	MONITORS VOLTAGE SUPPLIED TO THE MOTOR IN THE M-G SET. THIS WILL DISABLE THE CONTROLS AND SET THE BRAKES IF THE VOLTAGE IS LOST.	a. COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. BRAKES WILL BE SET. DELAY OF OPERATION.	NO EFFECT.	3
		N.O. CONTACT CLOSING TO ENERGIZE RELAY 2SRX. RELAY 2SRX CONTACT CLOSING TO BYPASS RESISTOR RESA WHICH ALLOWS AN INCREASE IN CURRENT TO THE DC MOTOR FIELD WINDINGS TO STRENGTHEN THE FIELD FOR NORMAL OPERATIONS.	a. N.O. CONTACT FAILS OPEN b. CORROSION, BINDING MECHANISM c. 09FY12-006.110 d. SELSYN POSITION INDICATOR e. PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	THE N.O. CONTACT WILL BE OPEN TO DEENERGIZE RELAY 2SRX. THIS PLACES RESISTOR RESA IN SERIES WITH THE DC MOTOR FIELD WINDINGS. THE FIELD WILL BE WEAKENED BY THE REDUCTION OF CURRENT THROUGH THE WINDINGS. THE HOIST SPEED WILL INCREASE TO APPROXIMATELY TWO TIMES THE COMMANDED SPEED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
		N.O. CONTACT, ARRANGED IN SERIES WITH RELAY CONTACT 2KRX CLOSING TO ENABLE THE HOIST CONTROL CIRCUITRY.	a. N.O. CONTACT FAILS CLOSED	SERIES ARRANGED RELAY CONTACT 2FW WILL OPEN TO DEENERGIZE 2SRX. NO EFFECT ON NORMAL OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	CONTROL CIRCUITRY WILL NOT BE ENABLED. BRAKES WILL BE SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	RELAY CONTACT 2KRX, ARRANGED IN SERIES, WILL OPEN TO DISABLE THE CIRCUIT.	NO EFFECT.	3
		N.O. CONTACT CLOSING TO ENABLE FOOT SWITCH S2 FOR USE IN THE FLOAT CONTROL MODE.	a. N.O. CONTACT FAILS OPEN	FOOT SWITCH S2 WILL NOT BE ENABLED FOR THE FLOAT MODE. BRAKES WILL BE SET. DELAY OF OPERATION.	NO EFFECT.	3

Table 33 (Page 2 of 7). **ELECTRICAL FMEA - AUXILIARY HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 17/18/19 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2RF9, 2RF10	FUSE, 10A	N.O. CONTACT CLOSURES TO ENERGIZE FAN MOTORS M33 & M34 WHICH PROVIDE COOLING FOR THE DRIVE CONTROL RELAY CABINET.	a. N.O. CONTACT FAILS CLOSED	FOOT SWITCH S2 WILL REMAIN ENABLED. NO EFFECT ON NORMAL OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	FAN MOTORS WILL NOT COME ON. LOSS OF AIRFLOW IN THE RELAY CABINET. NO EFFECT ON CRANE OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	FAN MOTORS WILL REMAIN ON.	NO EFFECT.	3
		N.O. CONTACT, ARRANGED IN SERIES WITH RELAY CONTACT 2BTR CLOSURES TO ENERGIZE RELAY 2BRX, WHICH OPENS TO REDUCE THE CURRENT TO THE BRAKE SOLENOIDS AFTER THEY ARE ENERGIZED.	a. N.O. CONTACT FAILS OPEN	RELAY 2BRX WILL NOT BE ENERGIZED CAUSING POSSIBLE DAMAGE TO THE BRAKE SOLENOIDS OR TRIPPING OF CB 2CCB3. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	RELAY CONTACT 2BTR, ARRANGED IN SERIES, WILL OPEN TO DEENERGIZE RELAY 2BRX. NO EFFECT ON HOIST OPERATION.	NO EFFECT.	3
			a. PREMATURE ACTUATION	RELAY 2KR WILL BE DEENERGIZED WHICH WILL DISABLE THE HOIST CONTROLS. THE BRAKES WILL SET. DELAY OF OPERATIONS.	NO EFFECT.	3
		PROVIDES PROTECTION AGAINST AN OVERCURRENT CONDITION FOR 2KR RELAY COIL.	a. FAILS TO ACTUATE	2KR RELAY COIL MAY BE EXPOSED TO HIGHER THAN EXPECTED CURRENTS. POSSIBLE DAMAGE TO THE RELAY COIL. MULTIPLE FAILURE REQUIRED.	NO EFFECT.	3

Table 33 (Page 3 of 7). **ELECTRICAL FMEA - AUXILIARY HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 17/18/19 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2CCB2	CIRCUIT BREAKER, 15 AT	PROVIDES OVERLOAD PRO- TECTION FOR CIRCUIT PRO- VIDING POWER TO THE HOIST DC MOTOR FIELD WINDINGS.	a. PREMATURE TRIP a. FAILS TO TRIP	LOSS OF POWER TO THE HOIST DC MOTOR FIELD WINDINGS AND FIELD LOSS RELAY. M-G SET WILL SHUT DOWN WHEN 2FLA AND/OR 2FLB DEEN- ERGIZE. DELAY OF OPERATION. UPSTREAM BREAKER 12CB MAY TRIP CAUSING BRAKES TO SET. POSSIBLE DAMAGE TO THE MOTOR FIELD WINDINGS. DELAY OF OPERATION.	NO EFFECT. NO EFFECT.	3 3
2SRX	RELAY	PROVIDES PATH FOR FULL POWER TO THE DC MOTOR FIELD FOR NORMAL OPER- ATIONS WHEN ENERGIZED. WHEN IT IS DEENERGIZED THE DC MOTOR FIELD RECEIVES REDUCED POWER FOR HIGH SPEED OPER- ATIONS.	a. COIL FAILS OPEN b. CORROSION, FATIGUE c. 09FY12-006.111 d. SELSYN POSITION INDI- CATOR e. PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS a. N.O. CONTACT FAILS OPEN b. CORROSION, BINDING MECHANISM c. 09FY12-006.112 d. SELSYN POSITION INDI- CATOR e. PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS a. N.O. CONTACT FAILS CLOSED	THE N.O. CONTACT WILL BE OPENED PLACING RESISTOR RESA IN SERIES WITH THE DC MOTOR FIELD WINDINGS. THE FIELD WILL BE WEAK- ENED BY THE REDUCTION OF CURRENT THROUGH THE WINDINGS. THE HOIST SPEED WILL INCREASE TO APPROXIMATELY TWO TIMES THE COMMANDED SPEED. THE N.O. CONTACT WILL BE OPENED PLACING RESISTOR RESA IN SERIES WITH THE DC MOTOR FIELD WINDINGS. THE FIELD WILL BE WEAK- ENED BY THE REDUCTION OF CURRENT THROUGH THE WINDINGS. THE HOIST SPEED WILL INCREASE TO APPROXIMATELY TWO TIMES THE COMMANDED SPEED. LOSS OF ABILITY TO REDUCE THE POWER TO THE DC MOTOR FIELD FOR HIGH SPEED OPERATION.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM. POSSIBLE DAMAGE TO A VEHICLE SYSTEM. NO EFFECT.	2 2 3

Table 33 (Page 4 of 7). **ELECTRICAL FMEA - AUXILIARY HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 17/18/19 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2FLA	RELAY	PROVIDES PROTECTION IF POWER TO THE WEST DC MOTOR FIELD WINDING IS LOST. N.O. CONTACT WILL OPEN TO SHUT DOWN THE M-G SET.	a. COIL FAILS OPEN a. N.O. CONTACT FAILS OPEN a. N.O. CONTACT FAILS CLOSED	CONTACT WILL REMAIN IN DE-ENERGIZED POSITION. M-G SET WILL NOT RUN. DELAY OF OPERATION. M-G SET WILL NOT RUN. DELAY OF OPERATION. IF POWER IS LOST IN THE MOTOR FIELD WINDING CIRCUIT, THE CONTACT FOR RELAY 2FLB WILL OPEN TO SHUT DOWN THE M-G SET. IF ONE MOTOR FIELD WINDING OPENS, THE REMAINING OPERATIONAL MOTOR WILL HOLD LOAD.	NO EFFECT. NO EFFECT. NO EFFECT.	3 3 3
2FLB	RELAY	PROVIDES PROTECTION IF POWER TO THE EAST DC MOTOR FIELD WINDING IS LOST. N.O. CONTACT WILL OPEN TO SHUT DOWN THE M-G SET.	a. COIL FAILS OPEN a. N.O. CONTACT FAILS OPEN a. N.O. CONTACT FAILS CLOSED	CONTACT WILL REMAIN IN DE-ENERGIZED POSITION. M-G SET WILL NOT RUN. DELAY OF OPERATION. M-G SET WILL NOT RUN. DELAY OF OPERATION. IF POWER IS LOST IN THE MOTOR FIELD WINDING CIRCUIT, THE CONTACT FOR RELAY 2FLA WILL OPEN TO SHUT DOWN THE M-G SET. IF ONE MOTOR FIELD WINDING OPENS, THE REMAINING OPERATIONAL MOTOR WILL HOLD LOAD.	NO EFFECT. NO EFFECT. NO EFFECT.	3 3 3

Table 33 (Page 5 of 7). **ELECTRICAL FMEA - AUXILIARY HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
RESA	RESISTOR	PROVIDES VOLTAGE DIVIDING CAPABILITY TO REDUCE THE VOLTAGE ACROSS THE DC MOTOR FIELD WINDINGS FOR OPERATION IN THE HIGH SPEED MODE.	a. FAIL OPEN	NO POWER TO FIELD WINDINGS IN THE HIGH SPEED MODE. THE M-G SET WILL BE SHUT DOWN BY THE FIELD LOSS RELAYS. DELAY OF OPERATION.	NO EFFECT.	3
RESB	RESISTOR	PROVIDES VOLTAGE DIVIDING CAPABILITY TO REGULATE THE VOLTAGE ACROSS THE DC MOTOR FIELD WINDINGS.	a. FAILS OPEN	NO POWER TO FIELD WINDINGS. THE M-G SET WILL BE SHUT DOWN BY THE FIELD LOSS RELAYS. DELAY OF OPERATION.	NO EFFECT.	3
2RES1	RESISTOR, THYRITE	MAINTAINS PREDETERMINED VOLTAGE CEILING ACROSS THE DC MOTOR FIELD WINDINGS. THIS WILL NOT CONDUCT UNTIL IT REACHES THE BREAKDOWN VOLTAGE AT WHICH TIME IT WILL CONDUCT AND KEEP THE DC MOTOR FIELD WINDINGS AT THE PROPER VOLTAGE.	a. FAIL OPEN	THE DC MOTOR FIELD WINDINGS MAY BE EXPOSED TO HIGHER VOLTAGES THAN EXPECTED. POSSIBLE DAMAGE TO THE MOTOR FIELD WINDINGS.	NO EFFECT.	3
2FWR	RESISTOR	PROVIDES VOLTAGE DIVIDING CAPABILITY TO REDUCE THE VOLTAGE ACROSS THE DC MOTOR FIELD WINDINGS FOR OPERATION IN THE HIGH SPEED MODE.	a. FAIL OPEN	NO POWER TO FIELD WINDINGS IN THE HIGH SPEED MODE. THE M-G SET WILL BE SHUT DOWN BY THE FIELD LOSS RELAYS. DELAY OF OPERATION.	NO EFFECT.	3
2CCB3	CIRCUIT BREAKER, 30 AT	PROVIDES OVERLOAD PROTECTION FOR CIRCUIT PROVIDING POWER TO THE BRAKE SOLENOIDS.	a. PREMATURE TRIP	LOSS OF POWER TO THE BRAKE SOLENOIDS. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAILS TO TRIP	UPSTREAM CIRCUIT BREAKER 12CB MAY TRIP CAUSING BRAKES TO SET. POSSIBLE DAMAGE TO THE BRAKE SOLENOIDS. DELAY OF OPERATION.	NO EFFECT.	3

Table 33 (Page 6 of 7). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2BRX	RELAY	ENERGIZES TO REDUCE THE VOLTAGE DROP ON THE BRAKE SOLENOIDS AFTER THE INITIAL VOLTAGE REQUIRED TO RELEASE BRAKES HAS BEEN APPLIED.	a. COIL FAILS OPEN a. N.C. CONTACT FAILS CLOSED a. N.C. CONTACT FAILS OPEN	CONTACT REMAINS IN DE-ENERGIZED POSITION CAUSING POSSIBLE DAMAGE TO THE BRAKE SOLENOIDS OR TRIPPING OF CB 2CCB3. BRAKES WILL SET. DELAY OF OPERATION. POSSIBLE DAMAGE TO THE BRAKE SOLENOIDS OR TRIPPING OF CB 2CCB3. BRAKES WILL SET. DELAY OF OPERATION. BRAKE SOLENOIDS MAY NOT RECEIVE ENOUGH POWER TO RELEASE THE BRAKES. DELAY OF OPERATION.	NO EFFECT	3
RESC	RESISTOR	PROVIDES VOLTAGE DIVIDING TO REDUCE THE VOLTAGE ACROSS THE BRAKE SOLENOIDS AFTER THEY ARE INITIALLY ENERGIZED.	a. FAIL OPEN	NO POWER TO BRAKE SOLENOID. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
2RES2	RESISTOR, THYRITE	MAINTAINS PREDETERMINED VOLTAGE CEILING ACROSS THE BRAKE SOLENOIDS. THIS WILL NOT CONDUCT UNTIL IT REACHES THE BREAKDOWN VOLTAGE AT WHICH TIME IT WILL CONDUCT AND KEEP THE BRAKE SOLENOIDS AT THE PROPER VOLTAGE	a. FAIL OPEN	BRAKE SOLENOIDS MAY BE EXPOSED TO HIGHER VOLTAGES THAN EXPECTED. POSSIBLE DAMAGE TO THE SOLENOIDS.	NO EFFECT.	3

Table 33 (Page 7 of 7). **ELECTRICAL FMEA - AUXILIARY HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 17/18/19 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 17 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
BR	BRAKE SOLENOID (1 OF 2)	WHEN COIL, CONTROLLED BY RELAYS 2BR, 2BR1 AND 2BR2, IS ENERGIZED, BRAKES WILL RELEASE.	a. COIL FAILS OPEN	BRAKE WILL SET. DELAY OF OPERA- TION.	NO EFFECT.	3
PL36	INDICATION LAMP	PROVIDES INDICATION THAT BRAKES ARE SET.	a. FAILS OPEN	LIGHT WILL NOT COME ON TO INDI- CATE BRAKES ARE SET.	NO EFFECT.	3

Table 34 (Page 1 of 14). **ELECTRICAL FMEA - AUXILIARY HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 17/19/20 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 19 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2KRX	RELAY	PROVIDES PROTECTION AGAINST THE LOSS OF POWER TO THE GENERATOR FIELD DC INPUT CONTROLLER. RELAYS 2KR1, 2KR2, & 2KR3 MONITOR THIS POWER AND ENERGIZE THIS RELAY. THIS ENABLES THE HOIST CONTROLS IF THE POWER IS PRESENT AND IT DISABLES THE CONTROLS IF THE POWER IS NOT PRESENT.	a. COIL FAILS OPEN	CONTACT REMAINS IN DE-ENERGIZED POSITION. HOIST CONTROLS WILL REMAIN DISABLED. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	HOIST CONTROLS WILL REMAIN DISABLED. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	LOSS OF ABILITY TO DISABLE THE HOIST CONTROLS IF POWER IS LOST TO ONE OF THE THREE RELAYS. MULTIPLE FAILURE REQUIRED.	NO EFFECT.	3
2KR1	RELAY	MONITORS POWER SUPPLIED TO THE GENERATOR FIELD DC INPUT CONTROLLER DOWNSTREAM OF TRANSFORMER 2RT1. THE N.O. CONTACT IS ARRANGED IN SERIES WITH CONTACTS OF RELAYS 2KR2 & 2KR3 WHICH CLOSE TO ENERGIZE RELAY 2KRX.	a. COIL FAILS OPEN	CONTACT REMAINS IN DE-ENERGIZED POSITION. RELAY 2KRX WILL REMAIN DEENERGIZED. HOIST CONTROLS WILL REMAIN DISABLED. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	RELAY 2KRX WILL REMAIN DEENERGIZED. HOIST CONTROLS WILL REMAIN DISABLED. DELAY OF OPERATIONS.	NO EFFECT.	3

Table 34 (Page 2 of 14). **ELECTRICAL FMEA - AUXILIARY HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 17/19/20 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 19 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2KR2	RELAY	MONITORS POWER SUPPLIED TO THE GENERATOR FIELD DC INPUT CONTROLLER DOWNSTREAM OF TRANSFORMER 2RT1. THE N.O. CONTACT IS ARRANGED IN SERIES WITH CONTACTS OF RELAYS 2KR1 & 2KR3 WHICH CLOSE TO ENERGIZE RELAY 2KRX.	a. N.O. CONTACT FAILS CLOSED	LOSS OF ABILITY TO DISABLE THE HOIST CONTROLS IF POWER FROM TRANSFORMER 2RT1 IS LOST. MULTIPLE FAILURE REQUIRED.	NO EFFECT.	3
			a. COIL FAILS OPEN	CONTACT REMAINS IN DE-ENERGIZED POSITION. RELAY 2KRX WILL REMAIN DEENERGIZED. HOIST CONTROLS WILL REMAIN DISABLED. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	RELAY 2KRX WILL REMAIN DEENERGIZED. HOIST CONTROLS WILL REMAIN DISABLED. DELAY OF OPERATIONS.	NO EFFECT.	3
2KR3	RELAY	MONITORS POWER SUPPLIED TO THE GENERATOR FIELD DC INPUT CONTROLLER DOWNSTREAM OF TRANSFORMER 2RT2. THE N.O. CONTACT IS ARRANGED IN SERIES WITH CONTACTS OF RELAYS 2KR1 & 2KR2 WHICH CLOSE TO ENERGIZE RELAY 2KRX.	a. N.O. CONTACT FAILS CLOSED	LOSS OF ABILITY TO DISABLE THE HOIST CONTROLS IF POWER FROM TRANSFORMER 2RT1 IS LOST. MULTIPLE FAILURE REQUIRED.	NO EFFECT.	3
			a. COIL FAILS OPEN	CONTACT REMAINS IN DE-ENERGIZED POSITION. RELAY 2KRX WILL REMAIN DEENERGIZED. HOIST CONTROLS WILL REMAIN DISABLED. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	RELAY 2KRX WILL REMAIN DEENERGIZED. HOIST CONTROLS WILL REMAIN DISABLED. DELAY OF OPERATIONS.	NO EFFECT.	3

Table 34 (Page 3 of 14). **ELECTRICAL FMEA - AUXILIARY HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 17/19/20 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 19 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2RF1, 2RF2	FUSE, 5A	PROVIDES PROTECTION AGAINST AN OVERCURRENT CONDITION UPSTREAM OF TRANSFORMER 2RT1.	a. N.O. CONTACT FAILS CLOSED a. PREMATURE ACTUATION a. FAILS TO ACTUATE	LOSS OF ABILITY TO DISABLE THE HOIST CONTROLS IF POWER FROM TRANSFORMER 2RT2 IS LOST. MUL- TIPLE FAILURE REQUIRED. RELAYS 2KR1, & 2KR2 WILL BE DEEN- ERGIZED WHICH WILL DISABLE THE HOIST CONTROLS. THE BRAKES WILL SET. DELAY OF OPERATIONS. TRANSFORMER 2RT1 AND GENERATOR FIELD DC INPUT CONTROLLER MAY BE EXPOSED TO HIGHER THAN EXPECTED CURRENTS. POSSIBLE DAMAGE TO THESE COMPONENTS. MULTIPLE FAILURE REQUIRED.	NO EFFECT. NO EFFECT. NO EFFECT.	3 3 3
2RF3	FUSE, 10A	PROVIDES PROTECTION AGAINST AN OVERCURRENT CONDITION DOWNSTREAM OF TRANSFORMER 2RT1.	a. PREMATURE ACTUATION a. FAILS TO ACTUATE	RELAY 2KR1 WILL BE DEENERGIZED WHICH WILL DISABLE THE HOIST CON- TROLS. THE BRAKES WILL SET. DELAY OF OPERATIONS. GENERATOR FIELD DC INPUT CON- TROLLER MAY BE EXPOSED TO HIGHER THAN EXPECTED CURRENTS. POSSIBLE DAMAGE TO THIS COMPO- NENT. MULTIPLE FAILURE REQUIRED.	NO EFFECT. NO EFFECT.	3 3
2RF4	FUSE, 10A	PROVIDES PROTECTION AGAINST AN OVERCURRENT CONDITION DOWNSTREAM OF TRANSFORMER 2RT1.	a. PREMATURE ACTUATION a. FAILS TO ACTUATE	RELAY 2KR2 WILL BE DEENERGIZED WHICH WILL DISABLE THE HOIST CON- TROLS. THE BRAKES WILL SET. DELAY OF OPERATIONS. GENERATOR FIELD DC INPUT CON- TROLLER MAY BE EXPOSED TO HIGHER THAN EXPECTED CURRENTS. POSSIBLE DAMAGE TO THIS COMPO- NENT. MULTIPLE FAILURE REQUIRED.	NO EFFECT. NO EFFECT.	3 3

Table 34 (Page 4 of 14). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 17/19/20 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 19 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2RF5, 2RF6	FUSE, .5A	PROVIDES PROTECTION AGAINST AN OVERCURRENT CONDITION UPSTREAM OF TRANSFORMER 2RT2.	a. PREMATURE ACTUATION a. FAILS TO ACTUATE	RELAY 2KR3 WILL BE DEENERGIZED WHICH WILL DISABLE THE HOIST CON- TROLS. THE BRAKES WILL SET. DELAY OF OPERATIONS. TRANSFORMER 2RT2 AND GENERATOR FIELD DC INPUT CONTROLLER MAY BE EXPOSED TO HIGHER THAN EXPECTED CURRENTS. POSSIBLE DAMAGE TO THESE COMPONENTS. MULTIPLE FAILURE REQUIRED.	NO EFFECT. NO EFFECT.	3 3
2RF7, 2RF8	FUSE, .5A	PROVIDES PROTECTION AGAINST AN OVERCURRENT CONDITION DOWNSTREAM OF TRANSFORMER 2RT2.	a. PREMATURE ACTUATION a. FAILS TO ACTUATE	RELAY 2KR3 WILL BE DEENERGIZED WHICH WILL DISABLE THE HOIST CON- TROLS. THE BRAKES WILL SET. DELAY OF OPERATIONS. GENERATOR FIELD DC INPUT CON- TROLLER MAY BE EXPOSED TO HIGHER THAN EXPECTED CURRENTS. POSSIBLE DAMAGE TO THIS COMPO- NENT. MULTIPLE FAILURE REQUIRED.	NO EFFECT. NO EFFECT.	3 3
2RT1	ISOLATION TRANS- FORMER	STEPS DOWN THE BUS VOLTAGE OF 480V TO THE DESIRED VOLTAGE OF 240V FOR USE IN THE GENERATOR FIELD DC INPUT CON- TROLLER.	a. FAILS OPEN OR SHORT	LOSS OF POWER TO THE GENERATOR FIELD DC INPUT CONTROLLER. RELAYS 2KR1 & 2KR2 WILL BE DEEN- ERGIZED TO DISABLE THE HOIST CONTROL CIRCUIT. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
2RT2	CONTROL TRANS- FORMER	STEPS DOWN THE BUS VOLTAGE OF 480V TO THE DESIRED VOLTAGE OF 120V FOR USE IN THE GENERATOR FIELD DC INPUT CON- TROLLER.	a. FAILS OPEN OR SHORT	LOSS OF POWER TO THE GENERATOR FIELD DC INPUT CONTROLLER. RELAY 2KR3 WILL BE DEENERGIZED TO DISABLE THE HOIST CONTROL CIRCUIT. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3

Table 34 (Page 5 of 14). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 17/19/20 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 19 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2FC	GENERATOR FIELD DC INPUT CON- TROLLER	A SOLID STATE ASSEMBLY WHICH PROVIDES DC EXCITATION TO THE GENER- ATOR FIELD OF THE MOTOR-GENERATOR SET (M9-G3). THE EXCITATION IS PROPORTIONAL TO THE INPUT SUPPLIED FROM THE CONTROL POTENTIOMETERS (RPOT/FPOT) AND IS USED TO DRIVE THE DC MOTORS WHICH CONTROL THE HOIST.	a. NO OUTPUT b. CONTAMINATION, COR- ROSION, BOARD COMPO- NENT OPEN c. 09FY12-006.084 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. BRING THE MASTER CONTROLLER TO NEUTRAL OR PRESS E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	NO DC EXCITATION TO THE GENER- ATOR FIELD WINDING. NO OUTPUT FROM GENERATOR. NO HOIST MOTOR TORQUE WHILE THE COMMAND IS BEING GIVEN TO RAISE, LOWER, OR FLOAT THE LOAD AND THE BRAKES ARE RELEASED. LOAD WILL DESCEND WITH REGENERATIVE BRAKING APPLIED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. HIGH OUTPUT (NOT INVERTED) b. BOARD COMPONENT SHORT, BOARD COMPO- NENT OPEN, LOSS OF VOLTAGE FEEDBACK FROM THE DC DRIVE MOTOR LOOP c. 09FY12-006.085 d. HIGH INDICATION OF CURRENT ON CONSOLE AMMETER, OR SPEED ON THE SELSYN e. BRING THE MASTER CONTROLLER TO NEUTRAL OR PRESS E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	INCREASE IN SPEED OF THE DC MOTORS CONTROLLING THE HOIST IN THE DIRECTION COMMANDED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2

Table 34 (Page 6 of 14). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 17/19/20 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 19 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2XR1	RELAY	ENABLES THE GENERATOR FIELD DC INPUT CONTROLLER WHEN RELAY 2HCR OR 2LCR IS ENERGIZED.	a. HIGH OUTPUT (INVERTED) b. BOARD COMPONENT SHORT c. 09FY12-006.086 d. HIGH INDICATION OF CURRENT ON CONSOLE AMMETER, OR SPEED ON THE SELSYN e. BRING THE MASTER CONTROLLER TO NEUTRAL OR PRESS E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	INCREASE IN SPEED OF THE DC MOTORS CONTROLLING THE HOIST, IN THE OPPOSITE DIRECTION THAN COM- MANDED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. COIL FAILS OPEN b. CORROSION, FATIGUE c. 09FY12-006.080 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. BRING THE MASTER CONTROLLER TO NEUTRAL OR PRESS E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	CONTACTS REMAIN IN DE-ENERGIZED POSITION. NO DC EXCITATION TO THE GENERATOR FIELD. NO OUTPUT FROM GENERATOR. NO HOIST MOTOR TORQUE WHILE THE COMMAND IS BEING GIVEN, VIA THE MASTER CONTROL SWITCH, TO RAISE OR LOWER AND THE BRAKES ARE RELEASED. LOAD WILL DESCEND WITH REGENERATIVE BRAKING APPLIED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2

Table 34 (Page 7 of 14). **ELECTRICAL FMEA - AUXILIARY HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 17/19/20 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 19 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
		N.O. CONTACT CLOSURES TO ENABLE THE SPEED REGU- LATOR IN THE GENERATOR FIELD DC INPUT CON- TROLLER.	a. N.O. CONTACT FAILS OPEN b. CORROSION, BINDING MECHANISM c. 09FY12-006.081 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. BRING THE MASTER CONTROLLER TO NEUTRAL OR PRESS E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	THE SPEED REGULATOR IN THE GEN- ERATOR FIELD DC INPUT CONTROLLER WILL NOT BE ENABLED. NO DC EXCITATION TO THE GENERATOR FIELD. NO OUTPUT FROM GENER- ATOR. NO HOIST MOTOR TORQUE WHILE THE COMMAND IS BEING GIVEN, VIA THE MASTER CONTROL SWITCH, TO RAISE OR LOWER AND THE BRAKES ARE RELEASED. LOAD WILL DESCEND WITH REGENERATIVE BRAKING APPLIED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. N.O. CONTACT FAILS CLOSED	THE SPEED REGULATOR IN THE GEN- ERATOR FIELD DC INPUT CONTROLLER WILL REMAIN ENABLED. POSSIBLE DAMAGE TO THIS COMPONENT.	NO EFFECT.	3
		N.O. CONTACT CLOSURES TO ENABLE THE BI-DIRECTIONAL AMPLIFIER IN THE GENER- ATOR FIELD DC INPUT CON- TROLLER.	a. N.O. CONTACT FAILS OPEN b. CORROSION, BINDING MECHANISM c. 09FY12-006.082 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. BRING THE MASTER CONTROLLER TO NEUTRAL OR PRESS E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	THE BI-DIRECTIONAL AMPLIFIER IN THE GENERATOR FIELD DC INPUT CONTROLLER WILL NOT BE ENABLED. NO DC EXCITATION TO THE GENER- ATOR FIELD. NO OUTPUT FROM GEN- ERATOR. NO HOIST MOTOR TORQUE WHILE THE COMMAND IS BEING GIVEN, VIA THE MASTER CONTROL SWITCH, TO RAISE OR LOWER AND THE BRAKES ARE RELEASED. LOAD WILL DESCEND WITH REGENERATIVE BRAKING APPLIED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2

Table 34 (Page 8 of 14). **ELECTRICAL FMEA - AUXILIARY HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 17/19/20 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 19 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
		N.O. CONTACT CLOSURES TO ENABLE THE FIRING CIRCUIT IN THE GENERATOR FIELD DC INPUT CONTROLLER.	a. N.O. CONTACT FAILS CLOSED	THE BI-DIRECTIONAL AMPLIFIER IN THE GENERATOR FIELD DC INPUT CONTROLLER WILL REMAIN ENABLED. POSSIBLE DAMAGE TO THIS COMPO- NENT.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN b. CORROSION, BINDING MECHANISM c. 09FY12-006.083 d. NO INDICATION OF CURRENT ON CONSOLE AMMETER e. BRING THE MASTER CONTROLLER TO NEUTRAL OR PRESS E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	THE FIRING CIRCUIT IN THE GENER- ATOR FIELD DC INPUT CONTROLLER WILL NOT BE ENABLED. NO DC EXCITATION TO THE GENERATOR FIELD. NO OUTPUT FROM GENER- ATOR. NO HOIST MOTOR TORQUE WHILE THE COMMAND IS BEING GIVEN, VIA THE MASTER CONTROL SWITCH, TO RAISE OR LOWER AND THE BRAKES ARE RELEASED. LOAD WILL DESCEND WITH REGENERATIVE BRAKING APPLIED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. N.O. CONTACT FAILS CLOSED	THE FIRING CIRCUIT IN THE GENER- ATOR FIELD DC INPUT CONTROLLER WILL REMAIN ENABLED. POSSIBLE DAMAGE TO THIS COMPONENT.	NO EFFECT.	3

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FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2SYNT, 2SYNR2	SYNCHRO TRANS- MITTER AND RECEIVER ASSEMBLY (SELSYN)	PROVIDES HOIST POSITION AND MOTION INDICATION TO THE OPERATOR IN CAB. THE OPERATOR USES THIS INDI- CATOR TO DETERMINE MOVE- MENT DISTANCE WHEN REQUIRED TO MAKE SMALL INCREMENTAL MOVES FOR MATE OPERATIONS.	a. ERRONEOUS OUTPUT (INDICATION) b. CORROSION, BINDING MECHANISM c. 09FY12-006.113 d. LOAD MOVEMENT NOT CORRESPONDING WITH CHANGE ON CONSOLE METER e. RETURN THE MASTER CONTROLLER TO NEUTRAL f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	LOSS OF ACCURATE POSITION INDI- CATION OR LOAD MOTION INDICATION COULD RESULT IN IMPROPER LOAD POSITIONING.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
2FLT	RELAY	ENERGIZED WHEN THE FOOT SWITCH, S2, IS ENGAGED FOR FLOAT MODE OPERATIONS. THIS PREVENTS THE TIME DELAY RELAY, 2TDHC, FROM BEING ENERGIZED AND BYPASSING THE OVER- VOLTAGE RELAY, 2FOV, WHEN THE SPEED SELECTOR SWITCH, SS2, IS IN THE COARSE SPEED POSITION.	a. COIL FAILS OPEN a. N.C. CONTACT FAILS OPEN	CONTACT REMAINS IN DE-ENERGIZED POSITION. THE TIME DELAY RELAY WILL BE ENERGIZED AND BYPASS THE OVERVOLTAGE RELAY WHEN THE SPEED SELECTOR SWITCH, SS2, IS IN THE COARSE SPEED POSITION AND THE OPERATOR IS FLOATING THE LOAD. MULTIPLE FAILURE REQUIRED TO RESULT IN DAMAGE TO A VEHICLE SYSTEM. THE TIME DELAY RELAY WILL NOT BE ENERGIZED AND WILL NOT BYPASS THE OVERVOLTAGE RELAY. IF THE CRANE IS OPERATING IN THE COARSE SPEED MODE, THE OVERVOLTAGE RELAY WILL SHUT DOWN THE M-G SET WHEN THE VOLTAGE IN THE DC MOTOR LOOP REACHES 115% OF THE FULL FINE OUTPUT.	NO EFFECT. NO EFFECT.	3 3

Table 34 (Page 10 of 14). **ELECTRICAL FMEA - AUXILIARY HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 17/19/20 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 19 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2FOV	RELAY	PROTECTS AGAINST AN OVERVOLTAGE CONDITION IN THE DC MOTOR LOOP WHICH CAN RESULT IN A SPEED INCREASE OF THE HOIST. IT IS CONFIGURED TO SHUT DOWN THE M-G SET IF AN OVERVOLTAGE CONDITION (115% OF THE FULL FINE OUTPUT) IS DETECTED IN THE DC MOTOR LOOP WHILE IN THE FINE SPEED OR FLOAT MODE OF OPERATION.	a. N.C. CONTACT FAILS CLOSED	THE TIME DELAY RELAY WILL BE ENERGIZED AND BYPASS THE OVER- VOLTAGE RELAY WHEN THE SPEED SELECTOR SWITCH, SS2, IS IN THE COARSE SPEED POSITION AND THE OPERATOR IS FLOATING THE LOAD. MULTIPLE FAILURE REQUIRED TO RESULT IN DAMAGE TO A VEHICLE SYSTEM.	NO EFFECT.	3
			a. COIL FAILS OPEN	N.O. CONTACT WILL REMAIN IN THE DE-ENERGIZED POSITION. HOIST M-G SET CANNOT BE STARTED. DELAY OF OPERATION.	NO EFFECT.	3
			a. COIL FAILS TO DEENER- GIZE	LOSS OF ABILITY TO SHUT DOWN THE M-G SET IF AN OVERVOLTAGE CONDI- TION EXISTS IN THE DC MOTOR LOOP. MULTIPLE FAILURE REQUIRED TO RESULT IN DAMAGE TO A VEHICLE SYSTEM.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	HOIST M-G SET CANNOT BE STARTED. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	LOSS OF ABILITY TO SHUT DOWN THE M-G SET IF AN OVERVOLTAGE CONDI- TION EXISTS IN THE DC MOTOR LOOP. MULTIPLE FAILURE REQUIRED TO RESULT IN DAMAGE TO A VEHICLE SYSTEM.	NO EFFECT.	3

Table 34 (Page 11 of 14). **ELECTRICAL FMEA - AUXILIARY HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 17/19/20 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 19 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2FOV TRIP LIGHT	INDICATOR LIGHT	N.C. CONTACT CONTROLS POWER TO THE FOV TRIP LIGHT WHICH IS USED TO VERIFY PROPER OPERATION OF THIS RELAY DURING THE PRE-OPS CHECK.	a. N.C. CONTACT FAILS OPEN	FOV TRIP LIGHT WILL NOT COME ON. DELAY OF OPERATION.	NO EFFECT.	3
		LIGHTS WHEN THE FOV CON- TACTS ARE IN THE DEENER- GIZED POSITION TO INDICATE THAT THE FOV RELAY IS DISABLED WHICH WILL PREVENT THE M-G SET FROM BEING STARTED. THIS IS EXTINGUISHED WHEN THE FOV RELAY IS ENABLED TO ALLOW FOR M-G SET START.	a. N.C. CONTACT FAILS CLOSED	FOV TRIP LIGHT WILL REMAIN ON. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAIL OPEN	FAILS TO INDICATE THE PROPER OPERATION OF THE FOV RELAY. DELAY OF OPERATION.	NO EFFECT.	3
2FOV RECT	RECTIFIER, BRIDGE	MAINTAINS A POSITIVE VOLTAGE INPUT TO RELAY 2FOV REGARDLESS OF THE VOLTAGE POLARITY AND CURRENT DIRECTION IN THE DC MOTOR LOOP.	a. DIODE FAILS OPEN/SHORTED	NO INPUT FROM THE DC MOTOR LOOP TO THE OVERVOLTAGE RELAY. LOSS OF ABILITY TO SHUT DOWN THE M-G SET IF AN OVERVOLTAGE CONDITION EXISTS IN THE DC MOTOR LOOP. MULTIPLE FAILURE REQUIRED TO RESULT IN DAMAGE TO A VEHICLE SYSTEM.	NO EFFECT.	3

Table 34 (Page 12 of 14). ELECTRICAL FMEA - AUXILIARY HOIST						
System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 17/19/20 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 19 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2TDHC	RELAY, TIME DELAY	BYPASSES THE OVER- VOLTAGE RELAY, 2FOV, WHEN ENERGIZED BY POSITIONING THE SPEED SELECTOR SWITCH, SS2 TO COARSE SPEED. THE TIME DELAY IS SET TO PROVIDE TIME FOR THE VOLTAGE IN THE DC MOTOR LOOP TO GO BELOW THE 115% FULL FINE VOLTAGE THRESHOLD WHEN THE SPEED SELECTOR SWITCH IS POSITIONED FROM COARSE TO FINE SPEED WHILE THE CRANE IS IN MOTION. THIS PREVENTS INADVERTENT SHUT DOWNS OF THE M-G SET.	a. COIL FAILS OPEN	N.O. CONTACT WILL REMAIN IN THE DE-ENERGIZED POSITION AND WON'T BYPASS THE OVERVOLTAGE RELAY. IF THE CRANE IS OPERATING IN THE COARSE SPEED MODE, THE OVER- VOLTAGE RELAY WILL SHUT DOWN THE M-G SET WHEN THE VOLTAGE IN THE DC MOTOR LOOP REACHES 115% OF THE FULL FINE OUTPUT.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	THE OVERVOLTAGE RELAY WON'T BE BYPASSED. IF THE CRANE IS OPER- ATING IN THE COARSE SPEED MODE, THE OVERVOLTAGE RELAY WILL SHUT DOWN THE M-G SET WHEN THE VOLTAGE IN THE DC MOTOR LOOP REACHES 115% OF THE FULL FINE OUTPUT.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	THE OVERVOLTAGE RELAY WILL BE BYPASSED WHEN THE SPEED SELECTOR SWITCH IS IN THE FINE SPEED POSITION. MULTIPLE FAILURE REQUIRED TO RESULT IN DAMAGE TO A VEHICLE SYSTEM.	NO EFFECT.	3

Table 34 (Page 13 of 14). **ELECTRICAL FMEA - AUXILIARY HOIST**

System 175-TON BRIDGE CRANE, VAB Subsystem AUXILIARY HOIST Drawing No. 67-K-L-11348 Sheet No. 17/19/20 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 15, 16, 19 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2TDHH	RELAY, TIME DELAY	N.O. CONTACT CLOSURES TO ILLUMINATE THE INDICATOR WHICH SHOWS THAT THE TIME DELAY RELAY IS ENERGIZED AND BYPASSING THE OVERVOLTAGE RELAY.	a. N.O. CONTACT FAILS OPEN	NO INDICATION THAT THE RELAY IS ENERGIZED. DELAY OF OPERATION.	NO EFFECT.	3
		BYPASSES THE OVERVOLTAGE RELAY, 2FOV, WHEN ENERGIZED BY POSITIONING THE SPEED SELECTOR SWITCH, SS2, TO HIGH SPEED.	a. N.O. CONTACT FAILS CLOSED	THE INDICATION THAT THE RELAY IS ENERGIZED WILL BE ILLUMINATED CONSTANTLY. DELAY OF OPERATION.	NO EFFECT.	3
			a. COIL FAILS OPEN	N.O. CONTACT WILL REMAIN IN THE DE-ENERGIZED POSITION AND WON'T BYPASS THE OVERVOLTAGE RELAY. IF THE CRANE IS OPERATING IN THE HIGH SPEED MODE, THE OVERVOLTAGE RELAY WILL SHUT DOWN THE M-G SET WHEN THE VOLTAGE IN THE DC MOTOR LOOP REACHES 115% OF THE FULL FINE OUTPUT.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	THE OVERVOLTAGE RELAY WON'T BE BYPASSED. IF THE CRANE IS OPERATING IN THE HIGH SPEED MODE, THE OVERVOLTAGE RELAY WILL SHUT DOWN THE M-G SET WHEN THE VOLTAGE IN THE DC MOTOR LOOP REACHES 115% OF THE FULL FINE OUTPUT.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	THE OVERVOLTAGE RELAY WILL BE BYPASSED WHEN THE SPEED SELECTOR SWITCH IS IN THE FINE SPEED POSITION. MULTIPLE FAILURE REQUIRED TO RESULT IN DAMAGE TO A VEHICLE SYSTEM.	NO EFFECT.	3

System 175-TON BRIDGE CRANE, VAB
Subsystem AUXILIARY HOIST
Drawing No. 67-K-L-11348 Sheet No. 17/19/20
PMN K60-0528

Program SPACE SHUTTLE

Station Set/Facility Code TA
Date JULY 1993
Reference Figure Used 15, 16, 19
Prepared By C. CRABB, LSOC 52-11

FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
		N.O. CONTACT CLOSURES TO ILLUMINATE THE INDICATOR WHICH SHOWS THAT THE TIME DELAY RELAY IS ENERGIZED AND BYPASSING THE OVERVOLTAGE RELAY.	a. N.O. CONTACT FAILS OPEN	NO INDICATION THAT THE RELAY IS ENERGIZED. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	THE INDICATION THAT THE RELAY IS ENERGIZED WILL BE ILLUMINATED CONSTANTLY. DELAY OF OPERATION.	NO EFFECT.	3

Table 35 (Page 1 of 2). **ELECTRICAL FMEA - BRIDGE DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
3CB	BRIDGE DRIVE CIRCUIT BREAKER, 350 AT	PROVIDES OVERLOAD PRO- TECTION FOR BRIDGE CONTROL CIRCUITRY. CONTACT PROVIDES LATCHING FOR START RELAY 3SR.	a. PREMATURE TRIP	LOSS OF POWER TO BRIDGE DRIVE M.G. SET. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAIL TO TRIP	POSSIBLE DAMAGE TO THE BRIDGE CONTROL CIRCUITRY. UPSTREAM CB (MCB) MAY TRIP RESULTING IN LOSS OF POWER TO MAIN BUS. BRAKES WILL SET. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	M-G SET WILL NOT STAY RUNNING WHEN START BUTTON IS RELEASED. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	NO EFFECT ON STARTING OR RUNNING M-G SET.	NO EFFECT.	3
			a. SHUNT TRIP FAILS OPEN	LOSS OF ABILITY TO SHUT DOWN THE BRIDGE BY THE PHASE REVERSAL RELAY. POSSIBLE DAMAGE TO THE CRANE CONTROL CIRCUITRY. MUL- TIPLE FAILURE REQUIRED.	NO EFFECT	3
1-OL 2-OL 3-OL	OVERLOAD, THERMAL	PROVIDES OVERLOAD PRO- TECTION IN EACH OF THE THREE LEGS OF THE MOTOR OF THE M-G SET. THREE N.C. CONTACTS, ARRANGED IN SERIES, OPEN TO SHUT DOWN THE M-G SET.	a. PREMATURE ACTUATION	SHUTDOWN OF THE M-G SET CAUSING THE BRIDGE TO STOP. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3

Table 35 (Page 2 of 2). ELECTRICAL FMEA - BRIDGE DRIVE						
System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 Sheet No. 11/12/21/24 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
M1-G1	MOTOR- GENERATOR (M-G) SET, 125 HP - 60 KW	CONSISTS OF A 125 HP MOTOR COUPLED TO A 60 KW DC GENERATOR TO PROVIDE POWER TO THE ARMATURES OF THE FOUR 15 HP BRIDGE MOTORS.	a. FAILS TO ACTUATE a. N.C. CONTACT FAILS CLOSED a. N.C. CONTACT FAILS OPEN a. NO OUTPUT	POSSIBLE DAMAGE TO THE MOTOR IN THE M-G SET. UPSTREAM CB (3CB) MAY TRIP, RESULTING IN LOSS OF POWER TO THE M-G SET. BRAKES WILL SET. DELAY OF OPERATION. BACKUP CONTACT IN SERIES WILL OPEN TO SHUT DOWN M-G SET. M-G WILL NOT RUN. DELAY OF OPER- ATION. LOSS OF POWER TO BRIDGE MOTORS. DELAY OF OPERATION.	NO EFFECT. NO EFFECT. NO EFFECT. NO EFFECT.	3 3 3 3
M2, M3, M4, M5	MOTORS, 15 HP EACH	FOUR SHUNT WOUND DC MOTORS. TWO MOTOR ARMATURES ARE ARRANGED IN SERIES (M2 & M3, M4 & M5) ON EITHER SIDE OF THE BRIDGE TO PROVIDE MECHANICAL TORQUE TO DRIVE THE BRIDGE. THE FIELD WINDINGS PROVIDE A CONSTANT MAGNETIC FIELD TO WORK AGAINST THE VARYING MAGNETIC FIELD OF THE ARMATURE LOOP TO PRODUCE TORQUE.	a. OPEN ARMATURE WINDINGS a. OPEN FIELD WINDING	LOSS OF POWER TO TWO DRIVE MOTORS. BRIDGE SPEED WILL BE RESTRICTED. BRIDGE MAY SKEW. DELAY OF OPERATION. RELAY 3FLA, 3FLB, 3FLC, OR 3FLD WILL BE DE-ENERGIZED AND OPEN CONTACTS TO SHUT DOWN M-G SET. DELAY OF OPERATION.	NO EFFECT. NO EFFECT.	3 3

Table 36 (Page 1 of 7). **ELECTRICAL FMEA - BRIDGE DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
3-OS1	M-G OVER- SPEED SENSOR	PROVIDES CAPABILITY TO SHUT DOWN THE M-G SET IF AN OVERSPEED CONDITION EXISTS.	a. N.C. CONTACT FAILS CLOSED	LOSS OF M-G OVERSPEED PRO- TECTION. POSSIBLE DAMAGE TO THE M-G SET WHEN COUPLED WITH M-G OVERSPEED.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	UNABLE TO START M-G SET. DELAY OF OPERATION.	NO EFFECT.	3
OTG	GENERATOR OVERTEM- PERATURE SENSOR	PROVIDES CAPABILITY TO SHUT DOWN THE M-G SET IF AN OVERTEMPERATURE CON- DITION EXISTS.	a. N.C. CONTACT FAILS CLOSED	LOSS OF GENERATOR OVERTEMPER- ATURE PROTECTION. POSSIBLE DAMAGE TO THE M-G SET WHEN COUPLED WITH GENERATOR OVER- TEMPERATURE CONDITION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	UNABLE TO START M-G SET. DELAY OF OPERATION.	NO EFFECT.	3
3CCB	CIRCUIT BREAKER, 30 AT	PROVIDES OVERLOAD PRO- TECTION FOR CIRCUIT PRO- VIDING POWER TO BRIDGE DRIVE M-G SET.	a. PREMATURE TRIP	LOSS OF POWER TO BRIDGE DRIVE STARTER CONTROLS. BRIDGE DRIVE WILL STOP. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAILS TO TRIP	POSSIBLE DAMAGE TO THE BRIDGE CONTROL CIRCUITRY. UPSTREAM CB (3CB) MAY TRIP. LOSS OF POWER TO THE BRIDGE DRIVE M-G SET. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
3TR	RELAY, TIME	PROVIDES TIMED DELAY FOR DROPPING OUT THE START CIRCUIT AND PICKING UP THE RUN CIRCUIT FOR THE BRIDGE DRIVE M-G SET.	a. COILS FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. M-G SET WILL NOT GET FULL POWER. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	M-G SET WILL NOT GET FULL POWER. DELAY OF OPERATION.	NO EFFECT.	3

Table 36 (Page 2 of 7). **ELECTRICAL FMEA - BRIDGE DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 Sheet No. 21/22/24 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
3Y	RELAY	CONTROLS STARTING CURRENT FOR BRIDGE DRIVE M-G SET.	a. N.O. CONTACT FAILS CLOSED	M-G SET WILL GET FULL POWER WHEN START BUTTON IS PUSHED. POSSIBLY CAUSING CURRENT OVERLOAD TO TRIP. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	M-G SET WILL NOT GET FULL POWER. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	M-G SET WILL GET FULL POWER WHEN START BUTTON IS PUSHED, POSSIBLE CAUSING CURRENT OVERLOAD TO TRIP. DELAY OF OPERATION.		
			a. COIL FAILS OPEN	CONTACT WILL REMAIN IN DE-ENERGIZED POSITION. M-G SET WILL NOT START PROPERLY. EXCES- SIVE START-UP CURRENT TO M-G SET, THROUGH RELAY CONTACT 3R (RUN RELAY), WOULD CAUSE M-G SET OVERLOADS TO TRIP. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN (1 OF 2)	M-G SET WILL NOT START PROPERLY. EXCESSIVE START-UP CURRENT TO M-G SET, THROUGH RELAY CONTACT 3R (RUN RELAY), WOULD CAUSE M-G SET OVERLOADS TO TRIP. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED (1 OF 2)	CURRENT WILL BYPASS THIS PORTION OF THE CIRCUIT THROUGH RELAY CONTACT 3R (RUN RELAY). NO EFFECT ON CRANE OPERATION. RELAY CONTACT 3S WILL OPEN TO REMOVE POWER FROM THE START CIRCUIT.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	NO EFFECT ON STARTING OR RUNNING OF M-G SET.	NO EFFECT.	3

Table 36 (Page 3 of 7). ELECTRICAL FMEA - BRIDGE DRIVE						
System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 Sheet No. 21/22/24 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
3S	RELAY	ENERGIZES WHEN THE M-G SET IS STARTED TO PROVIDE LATCHING FOR RELAY 3SR (START RELAY). THIS ALSO CONTROLS THE STARTING CURRENT FOR THE BRIDGE M-G SET.	a. N.C. CONTACT FAILS OPEN	M-G SET WOULD NOT GET FULL POWER. DELAY OF OPERATION.	NO EFFECT.	3
			a. COIL FAILS OPEN	CONTACT WILL REMAIN IN DE-ENERGIZED POSITION. M-G SET WILL NOT START.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	M-G SET SHUTS OFF AFTER THE START BUTTON IS LET UP. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	M-G SET WILL RESTART AFTER THE STOP BUTTON IS RELEASED. THE POWER CAN BE REMOVED BY OPENING CIRCUIT BREAKER 3CB. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	M-G SET WILL NOT START PROPERLY. EXCESSIVE START-UP CURRENT TO M-G SET, THROUGH RELAY CONTACT 3R (RUN RELAY), WOULD CAUSE M-G SET OVERLOADS TO TRIP. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	CURRENT WILL BYPASS THIS PORTION OF THE CIRCUIT THROUGH RELAY CONTACT 3R (RUN RELAY). NO EFFECT ON CRANE OPERATION. IF ALL THREE CONTACTS ARE HELD CLOSED THE M-G SET WILL CONTINUE TO RUN AT A REDUCED VOLTAGE WHEN COMMANDED TO STOP. DELAY OF OPERATIONS.	NO EFFECT.	3

Table 36 (Page 4 of 7). **ELECTRICAL FMEA - BRIDGE DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 Sheet No. 21/22/24 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
3R	RELAY	CONTROLS RUNNING CURRENT TO THE BRIDGE M-G SET.	a. COIL FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. M-G SET WILL NOT GET FULL POWER. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	IF JUST ONE CONTACT IS HELD CLOSED IT COULD CAUSE AN EXCES- SIVE START CURRENT WHICH WOULD TRIP M-G SET OVERLOADS. DELAY OF OPERATIONS. OR IF ALL THREE CONTACTS ARE HELD CLOSED THE M-G SET WILL CONTINUE TO RUN WHEN COMMANDED TO STOP. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	MOTOR WOULD NOT GET THE PROPER RUN CURRENT. M-G SET WILL NOT RECEIVE FULL POWER. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	RELAY 3Y WILL BE DEENERGIZED BY SERIES ARRANGED CONTACT OF 3TR. NO EFFECT ON STARTING OR RUNNING OPERATIONS.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	M-G SET WILL NOT START PROPERLY. EXCESSIVE START-UP CURRENT TO M-G SET WOULD CAUSE M-G SET OVERLOADS TO TRIP. DELAY OF OPERATION.	NO EFFECT.	3
		N.O. CONTACT CLOSURES TO ENABLE THE BLOWER MOTOR STARTER RELAY 3MB.	a. N.O. CONTACT FAILS CLOSED	BLOWER MOTOR WILL BE SHUT DOWN BY SERIES ARRANGED CONTACTS OF THE OVERLOAD RELAYS 3OLR1, 3OLR2, 3OLR3, OR 3OLR4.	NO EFFECT.	3

Table 36 (Page 5 of 7). **ELECTRICAL FMEA - BRIDGE DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 Sheet No. 21/22/24 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
3L1A, 3L2A, 3L3A	AUTOTRANS- FORMER	REGULATES THE STARTING VOLTAGE FOR MOTOR M1 IN THE M-G SET. (1 PER PHASE LEG, 3 TOTAL).	a. N.O. CONTACT FAILS OPEN	BLOWER MOTOR WILL NOT BE STARTED WHEN THE M-G SET IS STARTED. THE BRIDGE MOTOR WINDING TEMPERATURE SENSOR WILL SHUT DOWN THE BRIDGE M-G SET IF A MOTOR OVERHEATS. DELAY OF OPER- ATION.	NO EFFECT.	3
3-OTT	AUTOTRANS- FORMER OVERTEM- PERATURE SENSOR	PROVIDES CAPABILITY TO SHUTDOWN BRIDGE DRIVE M-G SET IF AUTOTRANSFORMER OVER- HEATS.	a. FAILS OPEN	MOTOR M1 WILL NOT GET THE PROPER STARTING VOLTAGE. POS- SIBLE DAMAGE TO THE M-G SET. DELAY OF OPERATIONS.	NO EFFECT.	3
3-OTT	AUTOTRANS- FORMER OVERTEM- PERATURE SENSOR	PROVIDES CAPABILITY TO SHUTDOWN BRIDGE DRIVE M-G SET IF AUTOTRANSFORMER OVER- HEATS.	a. N.C. CONTACT FAILS CLOSED	POSSIBLE DAMAGE TO THE M-G SET. MULTIPLE FAILURE REQUIRED. DELAY OF OPERATION.	NO EFFECT.	3
3-OTT	AUTOTRANS- FORMER OVERTEM- PERATURE SENSOR	PROVIDES CAPABILITY TO SHUTDOWN BRIDGE DRIVE M-G SET IF AUTOTRANSFORMER OVER- HEATS.	a. N.C. CONTACT FAILS OPEN	M-G SET WILL NOT START. DELAY OF OPERATION.	NO EFFECT.	3
3TR1	CONTROL TRANS- FORMER	STEPS DOWN THE BUS VOLTAGE OF 480V TO THE DESIRED CONTROL VOLTAGE OF 120V FOR MAIN CONTROL POWER FOR THE BRIDGE DRIVE.	a. FAILS OPEN OR SHORT	LOSS OF CONTROL POWER. BRIDGE DRIVE M-G SET WILL STOP. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
3CCB1	BRIDGE DRIVE CONTROL POWER CIRCUIT BREAKER, 15 AT	PROVIDES OVERLOAD PRO- TECTION FOR CIRCUIT FUR- NISHING CONTROL POWER FOR THE BRIDGE DRIVE.	a. PREMATURE TRIP	LOSS OF CONTROL POWER TO THE BRIDGE DRIVE. M-G SET WILL STOP. BRAKES WILL SET. DELAY OF OPERA- TION.	NO EFFECT.	3

Table 36 (Page 6 of 7). **ELECTRICAL FMEA - BRIDGE DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 Sheet No. 21/22/24 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
S3	PUSH-BUTTON SWITCH, START AND STOP	PROVIDES POWER TO THE BRIDGE START RELAY 3SR TO START AND STOP THE M-G SET.	a. FAILS TO TRIP	POSSIBLE DAMAGE TO CONTROL CIRCUITRY. MULTIPLE FAILURE REQUIRED. UPSTREAM CB 3CCB MAY TRIP RESULTING IN LOSS OF POWER TO STARTING AND CONTROL CIRCUITS. M-G SET WILL STOP. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. START SWITCH FAILS OPEN	UNABLE TO START M-G SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. START SWITCH FAILS CLOSED	M-G SET WILL RESTART AFTER IT HAS BEEN SHUT DOWN WITH STOP BUTTON. M-G CAN BE SHUT DOWN BY OPENING CB 3CCB OR 3CCB1.	NO EFFECT.	3
			a. STOP SWITCH FAILS CLOSED	UNABLE TO SHUT DOWN M-G SET WITH S3. M-G CAN BE SHUT DOWN BY OPENING CB 3CCB OR 3CCB1.	NO EFFECT.	3
			a. STOP SWITCH FAILS OPEN	UNABLE TO START M-G SET. DELAY OF OPERATION.	NO EFFECT.	3
PL20	INDICATION LAMP	PROVIDES INDICATION THAT BRIDGE DRIVE M-G SET STARTING RELAY IS ENERGIZED.	a. FAILS OPEN	UNABLE TO DETERMINE IF STARTING RELAY IS ENERGIZED. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAILS SHORT	UNABLE TO ENERGIZE STARTING RELAY. DELAY OF OPERATION.	NO EFFECT.	3
3SR	RELAY	ENABLES THE BRIDGE CONTROL CIRCUITRY.	a. COIL FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. UNABLE TO START M-G SET. DELAY OF OPERATION.	NO EFFECT.	3

Table 36 (Page 7 of 7). **ELECTRICAL FMEA - BRIDGE DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 Sheet No. 21/22/24 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
		N.O. CONTACT CLOSES TO ENABLE THE BRIDGE MASTER CONTROL 3MC.	a. N.O. CONTACT FAILS OPEN	M-G SET WILL START BUT THE BRIDGE CANNOT BE MOVED, AND THE BRAKES CANNOT BE RELEASED WITH 3MC. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	LOSS OF ABILITY TO DISABLE 3MC WITH 3SR. SERIES ARRANGED N.O. RELAY CONTACT OF 3KRX, WILL DISABLE 3MC.	NO EFFECT.	3
		N.O. CONTACT CLOSES TO INITIATE AND MAINTAIN THE START AND RUN SEQUENCE FOR THE BRIDGE M-G SET.	a. N.O. CONTACT FAILS OPEN	M-G SET WILL NOT START. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	UNABLE TO SHUT DOWN M-G SET WITH STOP BUTTON. M-G SET CAN BE SHUT DOWN BY OPENING CIRCUIT BREAKER 3CCB.	NO EFFECT.	3

Table 37 (Page 1 of 11). ELECTRICAL FMEA - BRIDGE DRIVE						
System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 Sheet No. 21/22/24 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
3MC	MASTER CONTROL SWITCH	A "JOYSTICK" CONNECTED TO MECHANICAL CONTACTS (3MC-2 & 3MC-3) AND REFERENCE POTENTIOMETER (RPOT), TO PROVIDE THE OPERATOR CONTROL OF THE BRIDGE TRAVEL IN THE NORTH/SOUTH DIRECTION.	a. N.O. CONTACT FAILS OPEN (1 OF 2)	UNABLE TO DRIVE THE BRIDGE MOTORS AND RELEASE THE BRAKES. FOR NORMAL OPERATIONS. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED (1 OF 2)	BRAKES WILL NOT SET WHEN THE MASTER CONTROL LEVER IS RETURNED TO THE NEUTRAL POSITION. WITH RPOT CENTERED THERE WILL BE NO INPUT TO THE DC MOTORS AND THE BRIDGE WILL STOP.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	UNABLE TO START THE M-G SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	M-G SET CAN BE STARTED WITH THE "JOYSTICK" OUT OF DETENT. OPERATOR ERROR REQUIRED.	NO EFFECT.	3
3ECR	RELAY	CONTROLS POWER TO BRAKE RELAY, 3BR, TO RELEASE THE BRAKES DURING BRIDGE TRAVEL.	a. COIL FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. BRAKES WILL NOT RELEASE WHEN THE MASTER CONTROLLER IS MOVED OUT OF NEUTRAL, AND THE BRAKE SWITCH IS NOT ENGAGED, CAUSING POSSIBLE DAMAGE TO THE BRAKES. DELAY OF OPERATION.	NO EFFECT.	3

Table 37 (Page 2 of 11). **ELECTRICAL FMEA - BRIDGE DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 Sheet No. 21/22/24 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
3WCR	RELAY	CONTROLS POWER TO BRAKE RELAY, 3BR, TO RELEASE THE BRAKES DURING BRIDGE TRAVEL.	a. N.O. CONTACT FAILS OPEN	BRAKES WILL NOT RELEASE WHEN THE MASTER CONTROLLER IS MOVED OUT OF NEUTRAL, AND THE BRAKE SWITCH IS NOT ENGAGED, CAUSING POSSIBLE DAMAGE TO THE BRAKES. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	BRAKES WILL NOT SET WHEN THE MASTER CONTROL LEVER IS RETURNED TO THE NEUTRAL POSI- TION. WITH RPOT CENTERED THERE WILL BE NO INPUT TO THE DC MOTORS AND THE BRIDGE WILL STOP.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	RELAY 3WCR WILL NOT BE LOCKED OUT.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	UNABLE TO TRAVEL IN OPPOSITE DIRECTION. DELAY OF OPERATION.	NO EFFECT.	3
			a. COIL FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. BRAKES WILL NOT RELEASE WHEN THE MASTER CONTROLLER IS MOVED OUT OF NEUTRAL, AND THE BRAKE SWITCH IS NOT ENGAGED, CAUSING POSSIBLE DAMAGE TO THE BRAKES. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	BRAKES WILL NOT RELEASE WHEN THE MASTER CONTROLLER IS MOVED OUT OF NEUTRAL, AND THE BRAKE SWITCH IS NOT ENGAGED, CAUSING POSSIBLE DAMAGE TO THE BRAKES. DELAY OF OPERATION.	NO EFFECT.	3

Table 37 (Page 3 of 11). ELECTRICAL FMEA - BRIDGE DRIVE						
System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 Sheet No. 21/22/24 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
3ETLS 3WTLS	END TRAVEL LIMIT SWITCH	SETS THE BRAKES ON THE BRIDGE DRIVE IN THE EVENT THE END LIMIT OF TRAVEL IS REACHED.	a. N.O. CONTACT FAILS CLOSED	BRAKES WILL NOT SET WHEN THE MASTER CONTROL LEVER IS RETURNED TO THE NEUTRAL POSI- TION. WITH RPOT CENTERED THERE WILL BE NO INPUT TO THE DC MOTORS AND THE BRIDGE WILL STOP.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	RELAY 3ECR WILL NOT BE LOCKED OUT.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	UNABLE TO TRAVEL IN OPPOSITE DIRECTION. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. FAILS OPEN	BRAKES WILL NOT RELEASE UNLESS THE BRAKE SWITCH IS ENGAGED, CAUSING POSSIBLE DAMAGE TO THE BRAKES. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. FAILS CLOSED	POSSIBLE DAMAGE TO THE BRIDGE STRUCTURE. MULTIPLE FAILURE OR OPERATOR ERROR REQUIRED.	NO EFFECT.	3
HCR RUN	RELAY	CONTROLS RELAY 3RUN FOR ENERGIZING THE GENERATOR FIELD WINDING FOR BRIDGE TRAVEL.	a. COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. THE GENERATOR FIELD WINDING WILL NOT BE ENERGIZED. NO OUTPUT FROM GENERATOR. UNABLE TO MOVE BRIDGE. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	THE GENERATOR FIELD WINDING WILL NOT BE ENERGIZED. NO OUTPUT FROM GENERATOR. UNABLE TO MOVE BRIDGE. DELAY OF OPERATION.	NO EFFECT.	3

Table 37 (Page 4 of 11). **ELECTRICAL FMEA - BRIDGE DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 Sheet No. 21/22/24 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
		N.O. CONTACT, ARRANGED IN SERIES WITH 3VR, CLOSSES TO PROVIDE SELF LATCHING AND KEEP RELAY 3ECR ENERGIZED TO PROVIDE FOR A SMOOTH SLOW TO STOP MOVEMENT BY KEEPING THE BRAKES RELEASED UNTIL THE VOLTAGE IN THE DC MOTOR LOOP GOES BELOW A PREDETERMINED LIMIT.	a. N.O. CONTACT FAILS CLOSED	RELAY 3RUN N.O. CONTACT WILL REMAIN CLOSED WHEN THE JOYSTICK IS RETURNED TO CENTER. THERE WILL BE NO INPUT TO THE GENERATOR FIELD WINDING BECAUSE THE GENERATOR FIELD DC INPUT CONTROLLER WILL BE DISABLED.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	THE GENERATOR FIELD WINDING WILL NOT BE ENERGIZED. NO OUTPUT FROM GENERATOR. UNABLE TO MOVE BRIDGE. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	RELAY 3RUN N.O. CONTACT WILL DROP OUT (OPEN) BY GRAVITY AND/OR THE SPRING FORCE.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	BRAKES WILL SET IMMEDIATELY WHEN THE JOYSTICK IS RETURNED TO NEUTRAL. POSSIBLE DAMAGE TO THE BRAKES.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	SERIES ARRANGED CONTACT OF RELAY 3VR WILL OPEN WHEN THE VOLTAGE IN THE DC MOTOR GOES BELOW THE PREDETERMINED LEVEL TO DEENERGIZE RELAYS HCR RUN AND 3ECR. THE VOLTAGE IN THE DC MOTOR LOOP WILL DECREASE WHEN THE JOYSTICK IS RETURNED TO NEUTRAL.	NO EFFECT.	3

Table 37 (Page 5 of 11). **ELECTRICAL FMEA - BRIDGE DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 Sheet No. 21/22/24 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
LCR RUN	RELAY	CONTROLS RELAY 3RUN FOR ENERGIZING THE GENERATOR FIELD WINDING FOR BRIDGE TRAVEL.	a. COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. THE GENERATOR FIELD WINDING WILL NOT BE ENERGIZED. NO OUTPUT FROM GENERATOR. UNABLE TO MOVE BRIDGE. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	THE GENERATOR FIELD WINDING WILL NOT BE ENERGIZED. NO OUTPUT FROM GENERATOR. UNABLE TO MOVE BRIDGE. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	RELAY 3RUN N.O. CONTACT WILL REMAIN CLOSED WHEN THE JOYSTICK IS RETURNED TO CENTER. THERE WILL BE NO INPUT TO THE GENERATOR FIELD WINDING BECAUSE THE GENERATOR FIELD DC INPUT CONTROLLER WILL BE DISABLED.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	THE GENERATOR FIELD WINDING WILL NOT BE ENERGIZED. NO OUTPUT FROM GENERATOR. UNABLE TO MOVE BRIDGE. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	RELAY 3RUN N.O. CONTACT WILL DROP OUT (OPEN) BY GRAVITY AND/OR THE SPRING FORCE.	NO EFFECT.	3
		N.O. CONTACT, ARRANGED IN SERIES WITH 3VR, CLOSSES TO PROVIDE SELF LATCHING AND KEEP RELAY 3WCR ENERGIZED TO PROVIDE FOR A SMOOTH SLOW TO STOP MOVEMENT BY KEEPING THE BRAKES RELEASED UNTIL THE VOLTAGE IN THE DC MOTOR LOOP GOES BELOW A PREDETERMINED LIMIT.	a. N.O. CONTACT FAILS OPEN	BRAKES WILL SET IMMEDIATELY WHEN THE JOYSTICK IS RETURNED TO NEUTRAL. POSSIBLE DAMAGE TO THE BRAKES.	NO EFFECT.	3

Table 37 (Page 6 of 11). ELECTRICAL FMEA - BRIDGE DRIVE						
System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 Sheet No. 21/22/24 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
S1	BRAKE SWITCH	PROVIDES CAPABILITY TO RELEASE THE BRAKES WHILE MASTER CONTROL SWITCH IS IN THE NEUTRAL POSITION.	a. N.O. CONTACT FAILS CLOSED	SERIES ARRANGED CONTACT OF RELAY 3VR WILL OPEN WHEN THE VOLTAGE IN THE DC MOTOR GOES BELOW THE PREDETERMINED LEVEL TO DEENERGIZE RELAYS HCR RUN AND 3WCR. THE VOLTAGE IN THE DC MOTOR LOOP WILL DECREASE WHEN THE JOYSTICK IS RETURNED TO NEUTRAL.	NO EFFECT.	3
			a. FAILS OPEN	UNABLE TO RELEASE BRAKES WHILE MASTER CONTROL SWITCH IS IN NEUTRAL POSITION.	NO EFFECT.	3
			a. FAILS CLOSED	BRAKES WILL BE RELEASED WHILE THE MASTER CONTROL SWITCH IS IN THE NEUTRAL POSITION. WITH THE MASTER CONTROL SWITCH CENTERED THERE WILL BE NO INPUT TO THE DC MOTORS AND THE BRIDGE WILL STOP.	NO EFFECT.	3
3BR	RELAY, BRAKE	ENERGIZES TO PROVIDE POWER TO THE BRAKE SOLENOIDS TO RELEASE THE BRAKES.	a. COIL FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. BRAKES WILL NOT RELEASE WHEN THE MASTER CONTROLLER IS MOVED OUT OF NEUTRAL, OR THE BRAKE SWITCH IS ENGAGED, CAUSING POSSIBLE DAMAGE TO THE BRAKES. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN (1 OF 2)	BRAKES WILL NOT RELEASE WHEN THE MASTER CONTROLLER IS MOVED OUT OF NEUTRAL, OR THE BRAKE SWITCH IS ENGAGED, CAUSING POS- SIBLE DAMAGE TO THE BRAKES. DELAY OF OPERATION.	NO EFFECT.	3

Table 37 (Page 7 of 11). ELECTRICAL FMEA - BRIDGE DRIVE						
System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 Sheet No. 21/22/24 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
3SDR	RELAY, SLOW DOWN	ENERGIZED BY THE COARSE SPEED ENABLE SWITCH, 3CSES, TO ALLOW THE BRIDGE TO OPERATE IN COARSE SPEED. IT IS DE-ENERGIZED BY LIMIT SWITCH 3ESDLS OR 3WSDLS TO ALLOW TRAVEL ONLY IN THE FINE SPEED RANGE WHEN THE BRIDGE IS WITHIN 10 FEET FROM EACH END OF TRAVEL.	a. N.O. CONTACT FAILS CLOSED (1 OF 2)	SERIES ARRANGED CONTACT WILL OPEN TO SET BRAKES.	NO EFFECT.	3
			a. COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. BRIDGE WILL ONLY TRAVEL IN THE FINE SPEED RANGE.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN (1 OF 2)	BRIDGE WILL ONLY TRAVEL IN THE FINE SPEED RANGE.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED (1 OF 2)	BRIDGE TRAVEL SPEED WILL NOT REDUCE WHEN 10 FT. LIMIT IS REACHED. MULTIPLE FAILURE OR OPERATOR ERROR REQUIRED.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	RELAY WILL NOT REMAIN ENERGIZED WHEN THE COARSE SELECT ENABLE SWITCH IS RELEASED. BRIDGE WILL ONLY TRAVEL IN THE FINE SPEED RANGE.	NO EFFECT.	3
3CSES	SWITCH, COARSE SPEED ENABLE	ENERGIZES RELAY 3SDR TO ALLOW THE BRIDGE TO OPERATE IN THE COARSE SPEED RANGE.	a. N.O. CONTACT FAILS CLOSED	RELAY WILL REMAIN ENERGIZED. BRIDGE TRAVEL SPEED WILL NOT REDUCE WHEN 10 FT. LIMIT IS REACHED. MULTIPLE FAILURE OR OPERATOR ERROR REQUIRED.	NO EFFECT.	3
			a. FAILS OPEN	BRIDGE WILL ONLY TRAVEL IN THE FINE SPEED RANGE.	NO EFFECT.	3

Table 37 (Page 8 of 11). **ELECTRICAL FMEA - BRIDGE DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 Sheet No. 21/22/24 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
3EDLS, 3WDLS	SWITCH, LIMIT	OPENS TO DE-ENERGIZE RELAY 3SDR AND LIMIT THE BRIDGE TRAVEL TO THE FINE SPEED RANGE WHEN BRIDGE COMES WITHIN 10 FT. OF EACH END OF TRAVEL.	a. FAILS CLOSED a. FAILS OPEN	RELAY 3SDR WILL REMAIN ENER- GIZED. BRIDGE TRAVEL SPEED WILL NOT REDUCE WHEN 10 FT. LIMIT IS REACHED. MULTIPLE FAILURE OR OPERATOR ERROR REQUIRED. BRIDGE WILL ONLY TRAVEL IN THE FINE SPEED RANGE.	NO EFFECT. NO EFFECT.	3 3
5RECT	RECTIFIER, BRIDGE	CONVERTS 120V AC INPUT TO DC OUTPUT FOR ENERGIZING RELAY 3RUN FOR CONTROL- LING CURRENT TO THE GEN- ERATOR FIELD WINDING.	a. FAILS CLOSED a. DIODE FAILS OPEN	RELAY 3SDR WILL REMAIN ENER- GIZED. BRIDGE TRAVEL SPEED WILL NOT REDUCE WHEN 10 FT. LIMIT IS REACHED. MULTIPLE FAILURE OR OPERATOR ERROR REQUIRED. NO DC OUTPUT FROM 5RECT. IF THE FAILURE OCCURS WHILE 3RUN "DROP OUT" COIL IS ENERGIZED, THE GENERATOR FIELD WINDING WILL NOT BE ENERGIZED. THERE WILL BE NO OUTPUT FROM THE GENERATOR AND NO MOVEMENT FROM THE BRIDGE. DELAY OF OPERATIONS. OR IF THE FAILURE OCCURS WHILE 3RUN "PULL IN" COIL IS ENERGIZED THE N.O. CONTACT WILL DROP OUT (OPEN) BY GRAVITY AND/OR THE SPRING FORCE RESULTING IN NO MOVEMENT FROM THE BRIDGE. DELAY OF OPER- ATIONS.	NO EFFECT. NO EFFECT.	3 3

Table 37 (Page 9 of 11). **ELECTRICAL FMEA - BRIDGE DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 Sheet No. 21/22/24 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
3RUN	RELAY	N.O. CONTACT CLOSURES TO ALLOW INPUT CURRENT FROM THE GENERATOR FIELD DC INPUT CONTROLLER TO THE M-G SET GENERATOR FIELD WINDING TO MOVE THE DC DRIVE MOTORS. N.C. CONTACT ALLOWS RESIDUAL CURRENT IN THE GENERATOR TO DIMINISH AFTER THE DRIVE MOTION IS COMPLETED.	a. DIODE FAILS SHORT	INCREASED CURRENT TO THE RELAY 3RUN COILS RESULTING IN THE COILS FAILING OPEN. IF THE FAILURE OCCURS WHILE 3RUN "DROP OUT" COIL IS ENERGIZED, THE GENERATOR FIELD WINDING WILL NOT BE ENERGIZED. THERE WILL BE NO OUTPUT FROM THE GENERATOR AND NO MOVEMENT FROM THE BRIDGE. DELAY OF OPERATIONS. OR IF THE FAILURE OCCURS WHILE 3RUN "PULL IN" COIL IS ENERGIZED, THE INCREASED CURRENT TO THE RELAY COIL RESULTS IN THE COIL FAILING OPEN. THE N.O. CONTACT WILL DROP OUT (OPEN) BY GRAVITY AND/OR THE SPRING FORCE. DELAY OF OPERATION.	NO EFFECT.	3
			a. "PULL IN" COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. GENERATOR FIELD WINDING WILL NOT BE ENERGIZED. NO OUTPUT FROM GENERATOR. DELAY OF OPERATION.	NO EFFECT.	3
			a. "DROP OUT" COIL FAILS OPEN.	THE N.O. CONTACT WILL DROP OUT (OPEN) BY GRAVITY AND/OR THE SPRING FORCE.	NO EFFECT.	3

Table 37 (Page 10 of 11). ELECTRICAL FMEA - BRIDGE DRIVE						
System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 Sheet No. 21/22/24 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
5RES	RESISTOR	PROVIDES A CURRENT LIMITER FOR THE RESIDUAL CURRENT IN THE GENERATOR AFTER THE DRIVE MOTION IS COMPLETED.	a. N.O. CONTACT FAILS OPEN/N.C. CONTACT FAILS CLOSED	GENERATOR FIELD WILL NOT BE ENER- GIZED. NO OUTPUT FROM GENER- ATOR. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED/N.C. CONTACT FAILS OPEN	N.O. CONTACT WILL REMAIN CLOSED WHEN THE JOYSTICK IS RETURNED TO CENTER. THERE WILL BE NO INPUT TO THE GENERATOR FIELD WINDING BECAUSE THE GENERATOR FIELD DC INPUT CONTROLLER WILL BE DISA- BLED.	NO EFFECT.	3
			a. FAILS OPEN	THE RESIDUAL CURRENT IN THE GEN- ERATOR WILL NOT BE DIMINISHED. NO EFFECT ON NORMAL OPERATIONS.	NO EFFECT.	3
			a. FAILS OPEN	NO INDICATION FOR MOTOR OVER- HEATING FROM LIGHT ALARM WILL SOUND.	NO EFFECT.	3
			a. FAILS OPEN	NO INDICATION FOR MOTOR OVER- HEATING FROM LIGHT ALARM WILL SOUND.	NO EFFECT.	3
			a. FAILS OPEN	NO INDICATION FOR MOTOR OVER- HEATING FROM LIGHT ALARM WILL SOUND.	NO EFFECT.	3
PL21	INDICATION LAMP	PROVIDES INDICATION THAT BRIDGE DRIVE MOTOR #1 IS OVERHEATING.	a. FAILS OPEN	NO INDICATION FOR MOTOR OVER- HEATING FROM LIGHT ALARM WILL SOUND.	NO EFFECT.	3
PL22	INDICATION LAMP	PROVIDES INDICATION THAT BRIDGE DRIVE MOTOR #2 IS OVERHEATING.	a. FAILS OPEN	NO INDICATION FOR MOTOR OVER- HEATING FROM LIGHT ALARM WILL SOUND.	NO EFFECT.	3
PL23	INDICATION LAMP	PROVIDES INDICATION THAT BRIDGE DRIVE MOTOR #3 IS OVERHEATING.	a. FAILS OPEN	NO INDICATION FOR MOTOR OVER- HEATING FROM LIGHT ALARM WILL SOUND.	NO EFFECT.	3
PL24	INDICATION LAMP	PROVIDES INDICATION THAT BRIDGE DRIVE MOTOR #4 IS OVERHEATING.	a. FAILS OPEN	NO INDICATION FOR MOTOR OVER- HEATING FROM LIGHT ALARM WILL SOUND.	NO EFFECT.	3
PL25	INDICATION LAMP	PROVIDES INDICATION THAT BRIDGE DRIVE BLOWER MOTOR #1 IS OVERHEATING.	a. FAILS OPEN	NO INDICATION FOR BLOWER MOTOR OVERHEATING FROM LIGHT.	NO EFFECT.	3

Table 37 (Page 11 of 11). **ELECTRICAL FMEA - BRIDGE DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
PL26	INDICATION LAMP	PROVIDES INDICATION THAT BRIDGE DRIVE BLOWER MOTOR #2 IS OVERHEATING.	a. FAILS OPEN	NO INDICATION FOR BLOWER MOTOR OVERHEATING FROM LIGHT.	NO EFFECT.	3
PL27	INDICATION LAMP	PROVIDES INDICATION THAT BRIDGE DRIVE BLOWER MOTOR #3 IS OVERHEATING.	a. FAILS OPEN	NO INDICATION FOR BLOWER MOTOR OVERHEATING FROM LIGHT.	NO EFFECT.	3
PL28	INDICATION LAMP	PROVIDES INDICATION THAT BRIDGE DRIVE BLOWER MOTOR #4 IS OVERHEATING.	a. FAILS OPEN	NO INDICATION FOR BLOWER MOTOR OVERHEATING FROM LIGHT.	NO EFFECT.	3

Table 38 (Page 1 of 2). **ELECTRICAL FMEA - BRIDGE DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 Sheet No. 22/23/28 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
3MB	RELAY	ENERGIZES TO TURN ON BLOWER MOTORS, M23, M24, M25 & M26, WHEN THE M-G SET IS STARTED.	a. COIL FAILS OPEN	CONTACTS REMAIN IN DEENERGIZED POSITION. THE BLOWER MOTORS WILL NOT START. POSSIBLE DAMAGE TO THE DC DRIVE MOTORS. THE BRIDGE MOTOR WINDING TEMPER- ATURE SENSOR WILL SHUT DOWN THE BRIDGE M-G SET IF NECESSARY.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	BLOWER MOTORS WILL NOT RECEIVE FULL POWER. POSSIBLE DAMAGE TO THE BLOWER MOTORS AND THE DC DRIVE MOTORS. THE BRIDGE MOTOR WINDING TEMPERATURE SENSOR WILL SHUT DOWN THE BRIDGE M-G SET IF NECESSARY.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	BLOWER MOTORS WILL BE SHUT OFF AS EXPECTED.	NO EFFECT.	3
3OLR1, 3OLR2, 3OLR3, 3OLR4	RELAY	RELAYS ENERGIZE TO ENABLE THE BLOWER MOTOR START RELAY 3MB. PRO- VIDES CAPABILITY TO SHUT DOWN ALL BLOWER MOTORS AND LIGHT BLOWER MOTOR OVERHEATING INDICATOR LIGHTS WHEN DEENERGIZED BY ONE OF THE BLOWER MOTOR OVERLOADS.	a. COIL FAILS OPEN	CONTACTS REMAIN IN DEENERGIZED POSITION. THE BLOWER MOTORS WILL NOT START. BLOWER MOTOR OVERHEATING INDICATION LIGHT WILL REMAIN ON. DELAY OF OPERA- TION.	NO EFFECT	3
			a. N.C. CONTACT FAILS CLOSED	BLOWER MOTOR OVERHEATING INDI- CATION LIGHT WILL REMAIN ON. DELAY OF OPERATION.	NO EFFECT	3

Table 38 (Page 2 of 2). **ELECTRICAL FMEA - BRIDGE DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 Sheet No. 22/23/28 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
			a. N.C. CONTACT FAILS OPEN	BLOWER MOTOR OVERHEATING INDICATION LIGHT WILL NOT COME ON IF AN OVERHEAT OCCURS. THE BLOWER MOTOR WILL BE SHUT DOWN BY THE N.O. CONTACT. THE BRIDGE MOTOR WINDING TEMPERATURE SENSOR WILL SHUT DOWN THE BRIDGE M-G SET IF NECESSARY.	NO EFFECT	3
			a. N.O. CONTACT FAILS OPEN	THE BLOWER MOTORS WILL NOT START. POSSIBLE DAMAGE TO THE DC DRIVE MOTORS. THE BRIDGE MOTOR WINDING TEMPERATURE SENSOR WILL SHUT DOWN THE BRIDGE M-G SET IF NECESSARY.	NO EFFECT	3
			a. N.O. CONTACT FAILS CLOSED	SERIES ARRANGED CONTACTS WILL OPEN TO SHUT DOWN THE BLOWER MOTORS.	NO EFFECT	3

Table 39 (Page 1 of 2). **ELECTRICAL FMEA - BRIDGE DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 Sheet No. 12/22 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
3ACR	RELAY	PROVIDES POWER TO ACTIVATE MOTOR OVERHEATING ALARM.	a. COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. OVERHEATING ALARM WILL NOT SOUND. NO EFFECT ON THE INDICATOR LIGHT.	NO EFFECT	3
			a. N.O. CONTACT FAILS OPEN	OVERHEATING ALARM WILL NOT SOUND. NO EFFECT ON THE INDICATOR LIGHT.	NO EFFECT	3
			a. N.O. CONTACT FAILS CLOSED	OVERHEATING ALARM WILL SOUND INADVERTENTLY. DELAY OF OPERATION.	NO EFFECT	3
D5	DIODE	PREVENTS BRIDGE MOTOR #1 OVERHEATING INDICATOR FROM COMING ON WHILE ALARM RELAY, 3ACR, IS ENERGIZED WHEN ONE OF THE OTHER THREE MOTORS OVERHEAT.	a. FAILS OPEN	ALARM WILL NOT SOUND WHEN MOTOR #1 OVERHEATS. INDICATION LIGHT WILL SIGNAL OPERATOR OF OVERHEAT CONDITION.	NO EFFECT.	3
			a. FAILS SHORT	BRIDGE MOTOR #1 OVERHEAT INDICATOR WILL COME ON WHEN ONE OF THE OTHER THREE MOTORS OVERHEAT. ALARM MAY NOT SOUND.	NO EFFECT.	3
D6	DIODE	PREVENTS BRIDGE MOTOR #2 OVERHEATING INDICATOR FROM COMING ON WHILE ALARM RELAY, 3ACR, IS ENERGIZED WHEN ONE OF THE OTHER THREE MOTORS OVERHEAT.	a. FAILS OPEN	ALARM WILL NOT SOUND WHEN MOTOR #2 OVERHEATS. INDICATION LIGHT WILL SIGNAL OPERATOR OF OVERHEAT CONDITION.	NO EFFECT.	3
			a. FAILS SHORT	BRIDGE MOTOR #2 OVERHEAT INDICATOR WILL COME ON WHEN ONE OF THE OTHER THREE MOTORS OVERHEAT. ALARM MAY NOT SOUND.	NO EFFECT.	3

Table 39 (Page 2 of 2). **ELECTRICAL FMEA - BRIDGE DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 Sheet No. 12/22 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
D7	DIODE	PREVENTS BRIDGE MOTOR #3 OVERHEATING INDICATOR FROM COMING ON WHILE ALARM RELAY, 3ACR, IS ENERGIZED WHEN ONE OF THE OTHER THREE MOTORS OVERHEAT.	a. FAILS OPEN	ALARM WILL NOT SOUND WHEN MOTOR #3 OVERHEATS. INDICATION LIGHT WILL SIGNAL OPERATOR OF OVERHEAT CONDITION.	NO EFFECT.	3
			a. FAILS SHORT	BRIDGE MOTOR #3 OVERHEAT INDI- CATOR WILL COME ON WHEN ONE OF THE OTHER THREE MOTORS OVER- HEAT. ALARM MAY NOT SOUND.	NO EFFECT.	3
D8	DIODE	PREVENTS BRIDGE MOTOR #4 OVERHEATING INDICATOR FROM COMING ON WHILE ALARM RELAY, 3ACR, IS ENERGIZED WHEN ONE OF THE OTHER THREE MOTORS OVERHEAT.	a. FAILS OPEN	ALARM WILL NOT SOUND WHEN MOTOR #4 OVERHEATS. INDICATION LIGHT WILL SIGNAL OPERATOR OF OVERHEAT CONDITION.	NO EFFECT.	3
			a. FAILS SHORT	BRIDGE MOTOR #4 OVERHEAT INDI- CATOR WILL COME ON WHEN ONE OF THE OTHER THREE MOTORS OVER- HEAT. ALARM MAY NOT SOUND.	NO EFFECT.	3

Table 40 (Page 1 of 9). **ELECTRICAL FMEA - BRIDGE DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
3K1	RELAY	OVERHEATING TEMPERATURE SENSING RELAY IS ACTUATED WHEN A THERMISTOR IN THE WINDINGS OF BRIDGE DRIVE MOTOR #1 REACHES A PREDETERMINED TEMPERATURE. THE CONTACTS CLOSE TO SOUND ALARM AND TURN ON OVERHEATING INDICATOR LIGHT.	a. THERMISTOR COIL FAILS OPEN	LOSS OF MOTOR OVERHEATING DETECTION CIRCUIT. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 3K3 TO SHUT DOWN M-G SET IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT	3
			a. THERMISTOR COIL FAILS SHORT	RELAY MAY BE ENERGIZED CAUSING ALARM TO SOUND AND OVERHEATING INDICATOR LIGHT TO COME ON. DELAY OF OPERATION.	NO EFFECT	3
			a. RELAY COILS FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. ALARM WILL NOT SOUND AND OVERHEATING INDICATOR LIGHT WILL NOT LIGHT IF A MOTOR OVERHEAT OCCURS. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 3K3 TO SHUT DOWN M-G SET IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT	3
			a. N.O. CONTACT FAILS OPEN	ALARM WILL NOT SOUND AND OVERHEATING INDICATOR LIGHT WILL NOT LIGHT IF A MOTOR OVERHEAT OCCURS. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 3K3 TO SHUT DOWN M-G SET IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT	3
			a. N.O. CONTACT FAILS CLOSED	OVERHEAT ALARM AND LIGHT WILL BE ON. DELAY OF OPERATION.	NO EFFECT	3

Table 40 (Page 2 of 9). **ELECTRICAL FMEA - BRIDGE DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
3K2	RELAY	OVERHEATING TEMPERATURE SENSING RELAY IS ACTUATED WHEN A THERMISTOR IN THE WINDINGS OF BRIDGE DRIVE MOTOR #2 REACHES A PREDETERMINED TEMPERATURE. THE CONTACTS CLOSE TO SOUND ALARM AND TURN ON OVERHEATING INDICATOR LIGHT.	a. THERMISTOR COIL FAILS OPEN	LOSS OF MOTOR OVERHEATING DETECTION CIRCUIT. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 3K4 TO SHUT DOWN M-G SET IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT	3
			a. THERMISTOR COIL FAILS SHORT	RELAY MAY BE ENERGIZED CAUSING ALARM TO SOUND AND OVERHEATING INDICATOR LIGHT TO COME ON. DELAY OF OPERATION.	NO EFFECT	3
			a. RELAY COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. ALARM WILL NOT SOUND AND OVERHEATING INDICATOR LIGHT WILL NOT LIGHT IF A MOTOR OVERHEAT OCCURS. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 3K4 TO SHUT DOWN M-G SET IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT	3
			a. N.O. CONTACT FAILS OPEN	ALARM WILL NOT SOUND AND OVERHEATING INDICATOR LIGHT WILL NOT LIGHT IF A MOTOR OVERHEAT OCCURS. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 3K4 TO SHUT DOWN M-G SET IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT	3
			a. N.O. CONTACT FAILS CLOSED	OVERHEAT ALARM AND LIGHT WILL BE ON. DELAY OF OPERATION.	NO EFFECT	3

Table 40 (Page 3 of 9). ELECTRICAL FMEA - BRIDGE DRIVE						
System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
3K3	RELAY	OVERHEATING TEMPERATURE SENSING RELAY IS ACTUATED WHEN A THERMISTOR IN THE WINDINGS OF BRIDGE DRIVE MOTOR #1 REACHES A PREDETERMINED TEMPERATURE. THE CONTACTS OPEN TO SHUT DOWN THE M-G SET.	a. THERMISTOR COIL FAILS OPEN	LOSS OF MOTOR OVERHEATING DETECTION CIRCUIT. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 3K1 TO SOUND ALARM AND LIGHT OVERHEATING INDICATOR LIGHT IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT	3
			a. THERMISTOR COIL FAILS SHORT	RELAY MAY BE ENERGIZED CAUSING M-G SET TO SHUT DOWN. DELAY OF OPERATION.	NO EFFECT	3
			a. RELAY COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 3K1 TO SOUND ALARM AND LIGHT OVERHEATING INDICATOR LIGHT IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT	3
			a. N.C. CONTACT FAILS CLOSED	M-G SET WILL NOT SHUT DOWN. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 3K1 TO SOUND ALARM AND LIGHT OVERHEATING INDICATOR LIGHT IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT	3
			a. N.C. CONTACT FAILS OPEN	M-G SET WILL NOT START. DELAY OF OPERATION.	NO EFFECT	3

Table 40 (Page 4 of 9). ELECTRICAL FMEA - BRIDGE DRIVE						
System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
3K4	RELAY	OVERHEATING TEMPERATURE SENSING RELAY IS ACTUATED WHEN A THERMISTOR IN THE WINDINGS OF BRIDGE DRIVE MOTOR #2 REACHES A PREDETERMINED TEMPERATURE. THE CONTACTS OPEN TO SHUT DOWN THE M-G SET.	a. THERMISTOR COIL FAILS OPEN	LOSS OF MOTOR OVERHEATING DETECTION CIRCUIT. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 3K2 TO SOUND ALARM AND LIGHT OVERHEATING INDICATOR LIGHT IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT	3
			a. THERMISTOR COIL FAIL SHORT	RELAY MAY BE ENERGIZED CAUSING M-G SET TO SHUT DOWN. DELAY OF OPERATION.	NO EFFECT	3
			a. RELAY COILS FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 3K2 TO SOUND ALARM AND LIGHT OVERHEATING INDICATOR LIGHT IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT	3
			a. N.C. CONTACT FAILS CLOSED	M-G SET WILL NOT SHUT DOWN. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 3K2 TO SOUND ALARM AND LIGHT OVERHEATING INDICATOR LIGHT IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT	3
			a. N.C. CONTACT FAILS OPEN	M-G SET WILL NOT START. DELAY OF OPERATION.	NO EFFECT	3

Table 40 (Page 5 of 9). **ELECTRICAL FMEA - BRIDGE DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 Sheet No. 21/22/23 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
3K5	RELAY	OVERHEATING TEMPERATURE SENSING RELAY IS ACTUATED WHEN A THERMISTOR IN THE WINDINGS OF BRIDGE DRIVE MOTOR #3 REACHES A PREDETERMINED TEMPERATURE. THE CONTACTS CLOSE TO SOUND ALARM AND TURN ON OVERHEATING INDICATOR LIGHT.	a. THERMISTOR COIL FAILS OPEN	LOSS OF MOTOR OVERHEATING DETECTION CIRCUIT. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 3K7 TO SHUT DOWN M-G SET IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT	3
			a. THERMISTOR COIL FAILS SHORT	RELAY MAY BE ENERGIZED, CAUSING ALARM TO SOUND AND OVERHEATING INDICATOR LIGHT TO COME ON. DELAY OF OPERATION.	NO EFFECT	3
			a. RELAY COILS FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. ALARM WILL NOT SOUND AND OVERHEATING INDICATOR LIGHT WILL NOT LIGHT. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 3K7 TO SHUT DOWN M-G SET IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT	3
			a. N.O. CONTACT FAILS OPEN	ALARM WILL NOT SOUND AND OVERHEATING INDICATOR LIGHT WILL NOT LIGHT IF A MOTOR OVERHEAT OCCURS. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 3K7 TO SHUT DOWN M-G SET IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT	3
			a. N.O. CONTACT FAILS CLOSED	OVERHEAT ALARM AND LIGHT WILL BE ON. DELAY OF OPERATION.	NO EFFECT	3

Table 40 (Page 6 of 9). ELECTRICAL FMEA - BRIDGE DRIVE						
System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
3K8	RELAY	OVERHEATING TEMPERATURE SENSING RELAY IS ACTUATED WHEN A THERMISTOR IN THE WINDINGS OF BRIDGE DRIVE MOTOR #4 REACHES A PREDETERMINED TEMPERATURE. THE CONTACTS CLOSE TO SOUND ALARM AND TURN ON OVERHEATING INDICATOR LIGHT.	a. THERMISTOR COIL FAILS OPEN	LOSS OF MOTOR OVERHEATING DETECTION CIRCUIT. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 3K8 TO SHUT DOWN M-G SET IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT	3
			a. THERMISTOR COIL FAILS SHORT	RELAY MAY BE ENERGIZED, CAUSING ALARM TO SOUND AND OVERHEATING INDICATOR LIGHT TO COME ON. DELAY OF OPERATION.	NO EFFECT	3
			a. RELAY COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. ALARM WILL NOT SOUND AND OVERHEATING INDICATOR LIGHT WILL NOT LIGHT IF A MOTOR OVERHEAT OCCURS. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 3K8 TO SHUT DOWN M-G SET IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT	3
			a. N.O. CONTACT FAILS OPEN	ALARM WILL NOT SOUND AND OVERHEATING INDICATOR LIGHT WILL NOT LIGHT IF A MOTOR OVERHEAT OCCURS. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 3K8 TO SHUT DOWN M-G SET IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT	3
			a. N.O. CONTACT FAILS CLOSED	OVERHEAT ALARM AND LIGHT WILL BE ON. DELAY OF OPERATION.	NO EFFECT	3

Table 40 (Page 7 of 9). **ELECTRICAL FMEA - BRIDGE DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 Sheet No. 21/22/23 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
3K7	RELAY	OVERHEATING TEMPERATURE SENSING RELAY IS ACTUATED WHEN A THERMISTOR IN THE WINDINGS OF BRIDGE DRIVE MOTOR #3 REACHES A PREDETERMINED TEMPERATURE. THE CONTACTS OPEN TO SHUT DOWN THE M-G SET.	a. THERMISTOR COIL FAILS OPEN	LOSS OF MOTOR OVERHEATING DETECTION CIRCUIT. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 3K5 TO SOUND ALARM AND LIGHT OVERHEATING INDICATOR LIGHT IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT	3
			a. THERMISTOR COIL FAILS SHORT	RELAY MAY BE ENERGIZED CAUSING M-G SET TO SHUT DOWN. DELAY OF OPERATION.	NO EFFECT	3
			a. RELAY COILS FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 3K5 TO SOUND ALARM AND LIGHT OVERHEATING INDICATOR LIGHT IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT	3
			a. N.C. CONTACT FAILS CLOSED	M-G SET WILL NOT SHUT DOWN. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 3K5 TO SOUND ALARM AND LIGHT OVERHEATING INDICATOR LIGHT IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT	3
			a. N.C. CONTACT FAILS OPEN	M-G SET WILL NOT START. DELAY OF OPERATION.	NO EFFECT	3

Table 40 (Page 8 of 9). **ELECTRICAL FMEA - BRIDGE DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
3K8	RELAY	OVERHEATING TEMPERATURE SENSING RELAY IS ACTUATED WHEN A THERMISTOR IN THE WINDINGS OF BRIDGE DRIVE MOTOR #4 REACHES A PREDETERMINED TEMPERATURE. THE CONTACTS OPEN TO SHUT DOWN THE M-G SET.	a. THERMISTOR COIL FAILS OPEN	LOSS OF MOTOR OVERHEATING DETECTION CIRCUIT. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 3K6 TO SOUND ALARM AND LIGHT OVERHEATING INDICATOR LIGHT IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT	3
			a. THERMISTOR COIL FAILS SHORT	RELAY MAY BE ENERGIZED CAUSING M-G SET TO SHUT DOWN. DELAY OF OPERATION.	NO EFFECT	3
			a. RELAY COILS FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 3K6 TO SOUND ALARM AND LIGHT OVERHEATING INDICATOR LIGHT IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT	3
			a. N.C. CONTACT FAILS CLOSED	M-G SET WILL NOT SHUT DOWN. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 3K6 TO SOUND ALARM AND LIGHT OVERHEATING INDICATOR LIGHT IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT	3
			a. N.C. CONTACT FAILS OPEN	M-G SET WILL NOT START. DELAY OF OPERATION.	NO EFFECT	3
3F3	FUSE	PROTECTS FAN MOTORS, M35 & M36, FROM CURRENT OVERLOAD.	a. PREMATURE ACTUATION	FAN MOTORS, M35 & M36, WILL STOP. LOSS OF AIRFLOW IN THE RELAY CABINET. NO EFFECT ON CRANE OPERATION.	NO EFFECT.	3
			a. FAILS TO ACTUATE	POSSIBLE DAMAGE TO THE FAN MOTORS, M35 & M36. MULTIPLE FAILURE REQUIRED.	NO EFFECT.	3

Table 40 (Page 9 of 9). **ELECTRICAL FMEA - BRIDGE DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 Sheet No. 21/22/23 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
M35, M36	FAN MOTORS	PROVIDES COOLING FOR THE DRIVE CONTROL RELAY CABINET.	a. FAILS TO OPERATE	LOSS OF AIRFLOW IN THE RELAY CABINET. NO EFFECT ON CRANE OPERATION.	NO EFFECT.	3

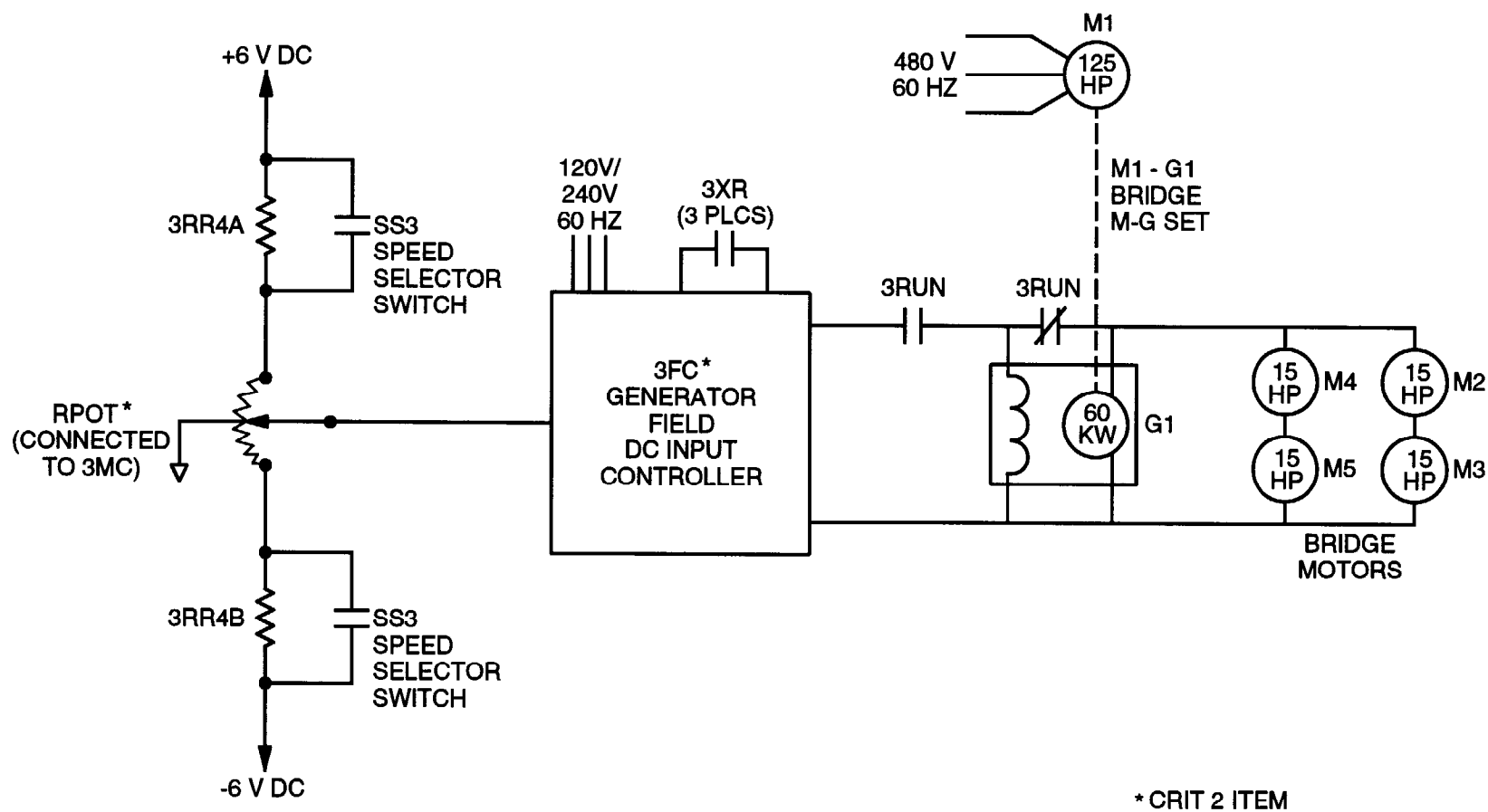


FIGURE 20. BRIDGE ELECTRICAL CONTROL SIMPLIFIED SCHEMATIC

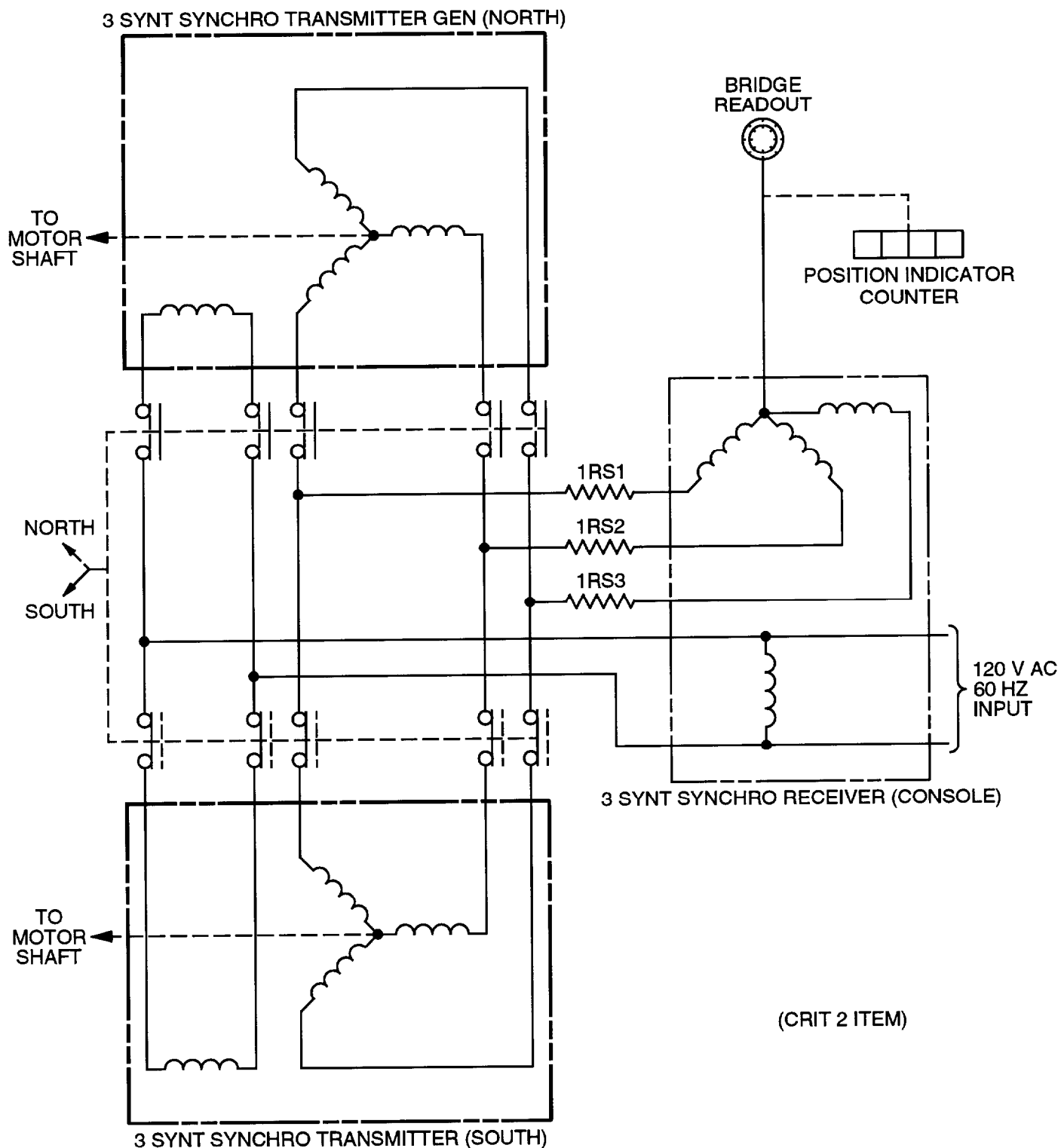


FIGURE 21. BRIDGE SYNCRO TRANSMITTER AND RECEIVER (SELSYN)

Table 41 (Page 1 of 4). ELECTRICAL FMEA - BRIDGE DRIVE						
System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 20 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
RPOT	POTENTIO- METER	REFERENCE POTENTIOMETER CONNECTED TO THE MASTER CONTROL SWITCH (JOYSTICK), 3MC, TO REGU- LATE THE INPUT EXCITATION VOLTAGE TO THE GENER- ATOR FIELD DC INPUT CON- TROLLER, 3FC, AND THE RESULTING OUTPUT TO THE GENERATOR FIELD WINDING FOR BRIDGE MOTION CONTROL.	a. FAIL OPEN b. CORROSION, FATIGUE c. 09FY12-006.115 d. CURRENT INDICATION ON CONSOLE AMMETER e. BRING THE MASTER CONTROLLER TO NEUTRAL OR PRESS E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	IF THE FAILURE OCCURS ON THE RESISTIVE ELEMENT, IT WOULD RESULT IN A LOSS OF THE PARALLEL RESISTANCE BRANCH AND CREATE A LARGER INPUT INTO THE GENERATOR FIELD DC INPUT CONTROLLER WHICH WILL CAUSE AN INCREASING SPEED OF THE DC MOTORS CONTROLLING THE BRIDGE. OR IF THE FAILURE OCCURS ON THE WIPER ARM IT WOULD RESULT IN NO GENERATOR FIELD DC INPUT CON- TROLLER EXCITATION VOLTAGE. NO GENERATOR FIELD WINDING VOLTAGE. NO OUTPUT FROM GENERATOR. THE BRIDGE WILL NOT MOVE. DELAY OF OPERATIONS.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
3RR4A, 3RR4B	RESISTOR	PROVIDES A VOLTAGE DIVIDER FOR THE +/- 6VDC POWER SOURCE TO RPOT, FOR INPUT TO THE GENER- ATOR FIELD DC INPUT CON- TROLLER, 3FC, TO ALLOW FOR BRIDGE OPERATION IN THE FINE SPEED MODE.	a. FAILS OPEN	NO GENERATOR FIELD DC INPUT CON- TROLLER EXCITATION VOLTAGE IN THE FINE SPEED MODE OF OPERA- TION. NO GENERATOR FIELD WINDING VOLTAGE. NO OUTPUT FROM GENER- ATOR. UNABLE TO OPERATE THE BRIDGE IN THE FINE SPEED MODE. DELAY OF OPERATIONS.	NO EFFECT.	3
3OLA	RELAY, OVERLOAD (INSTANTA- NEOUS)	SHUTS DOWN THE BRIDGE DRIVE M-G SET IF THE BRIDGE DRIVE MOTORS EXPERIENCE AN OVERLOAD. (NOTE GROUND RULE e).	a. N.C. CONTACT FAILS CLOSED a. N.C. CONTACT FAILS OPEN	M-G SET WILL NOT SHUT DOWN IF AN OVERLOAD CONDITION OCCURS. POS- SIBLE DAMAGE TO THE DC DRIVE MOTORS. MULTIPLE FAILURE REQUIRED. M-G SET WILL NOT RUN. DELAY OF OPERATION.	NO EFFECT. NO EFFECT.	3 3

Table 41 (Page 2 of 4). ELECTRICAL FMEA - BRIDGE DRIVE						
System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 20 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
7R, 8R	RESISTORS	PROVIDES CURRENT LIMITING FOR THE BRIDGE DRIVE MOTOR ARMATURE LOOPS.	a. FAILS OPEN	LOSS OF POWER TO TWO DRIVE MOTORS. BRIDGE SPEED WILL BE RESTRICTED. BRIDGE MAY SKEW. DELAY OF OPERATION.	NO EFFECT.	3
3AM	AMMETER	PROVIDES INDICATION AT THE CONSOLE OF THE CURRENT TO THE BRIDGE DRIVE MOTORS.	a. FAILS OPEN	LOSS OF INDICATION TO OPERATOR OF MOTOR CURRENT. DELAY OF OPERATION.	NO EFFECT.	3
3VR	RELAY, VOLTAGE	MONITORS VOLTAGE IN THE BRIDGE MOTOR LOOP AND PROVIDES LATCHING TO KEEP RELAYS HCR RUN, LCR RUN, 3ECR AND 3WCR ENERGIZED AFTER MASTER CONTROL SWITCH IS RETURNED TO THE NEUTRAL POSITION. THIS PREVENTS THE BRAKES FROM SETTING WHILE VOLTAGE IN THE MOTOR LOOP IS ABOVE A PREDETERMINED LIMIT.	a. COIL FAILS OPEN	CONTACT REMAINS IN DE-ENERGIZED POSITION. BRAKES WILL SET IMMEDIATELY WHEN THE MASTER CONTROL SWITCH IS MOVED TO THE STOP POSITION. POSSIBLE DAMAGE TO THE BRAKES.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	BRAKES WILL SET IMMEDIATELY WHEN THE MASTER CONTROL SWITCH IS MOVED TO THE STOP POSITION. POSSIBLE DAMAGE TO THE BRAKES.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	BRAKES WILL NOT SET WHEN THE MASTER CONTROL LEVER IS RETURNED TO THE NEUTRAL POSITION. WITH RPOT CENTERED THERE WILL BE NO INPUT TO THE DC MOTORS AND THE BRIDGE WILL STOP.	NO EFFECT.	3

Table 41 (Page 3 of 4). ELECTRICAL FMEA - BRIDGE DRIVE						
System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 20 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
3KR	RELAY	ENERGIZES WHEN THE M-G SET IS STARTED TO ENERGIZE RELAY 3SRX WHICH BYPASSES RESISTOR RESC TO STRENGTHEN THE DC MOTOR FIELDS. THIS ALSO SUPPLIES POWER TO THE CABINET FAN MOTORS M35 & M36.	a. COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. THE DC MOTOR FIELD WILL BE WEAKENED. THIS WILL REDUCE THE TORQUE CAPABILITY OF THE DC MOTORS WHICH WILL CAUSE THE BRIDGE TO STOP WHEN A LOAD IS ON THE HOOK. DELAY OF OPERATIONS. SEE GROUND RULE I. CABINET FAN MOTORS WILL NOT COME ON. IF OVERHEATING OCCURS, THERMAL OVERLOADS WILL SHUT DOWN THE M-G SET. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. CONTACT FAILS OPEN	THE DC MOTOR FIELD WILL BE WEAKENED. THIS WILL REDUCE THE TORQUE CAPABILITY OF THE DC MOTORS WHICH WILL CAUSE THE BRIDGE TO STOP WITH A LOAD ON THE HOOK. DELAY OF OPERATIONS. SEE GROUND RULE I.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	RELAY 3SRX WILL REMAIN ENERGIZED AND THE DC MOTOR FIELD WILL REMAIN AT FULL STRENGTH.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	FAN MOTORS WILL NOT COME ON. LOSS OF AIRFLOW IN THE RELAY CABINET. NO EFFECT ON CRANE OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	FAN MOTORS WILL REMAIN ON.	NO EFFECT.	3

Table 41 (Page 4 of 4). ELECTRICAL FMEA - BRIDGE DRIVE						
System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 Sheet No. 21/22/24 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 20 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
3RF9, 3RF10	FUSE, 10A	PROVIDES PROTECTION AGAINST AN OVERCURRENT CONDITION FOR 3KR RELAY COIL.	a. PREMATURE ACTUATION	RELAY 3KR WILL BE DEENERGIZED WHICH WILL DISABLE THE BRIDGE CONTROLS. THE BRAKES WILL SET. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. FAILS TO ACTUATE	3KR RELAY COIL MAY BE EXPOSED TO HIGHER THAN EXPECTED CURRENTS. POSSIBLE DAMAGE TO THE RELAY COIL. MULTIPLE FAILURE REQUIRED.	NO EFFECT.	3

System 175-TON BRIDGE CRANE, VAB
Subsystem BRIDGE DRIVE
Drawing No. 67-K-L-11348 **Sheet No.** 21
PMN K60-0528

Program SPACE SHUTTLE

Station Set/Facility Code TA
Date JULY 1993
Reference Figure Used
Prepared By C. CRABB, LSOC 52-11

FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
3CCB2	CIRCUIT BREAKER 15AT	PROVIDES OVERLOAD PRO- TECTION FOR CIRCUIT PRO- VIDING POWER TO THE BRIDGE DRIVE MOTOR FIELD WINDINGS AND BRAKE SOLENOIDS.	a. PREMATURE TRIP	LOSS OF POWER TO BRIDGE MOTOR FIELD WINDINGS AND BRAKE SOLENOIDS. FIELD LOSS RELAYS (3FLA, 3FLB, 3FLC, & 3FLD) WILL BE DEENERGIZED AND SHUT THE M-G SET DOWN. THE BRAKE SOLENOIDS WILL BE DEENERGIZED AND SET THE BRAKES. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAILS TO TRIP	UPSTREAM BREAKER 12CB MAY TRIP CAUSING BRAKES TO SET. POSSIBLE DAMAGE TO THE MOTOR FIELD WINDINGS AND BRAKE SOLENOIDS. DELAY OF OPERATION.	NO EFFECT.	3
3SRX	RELAY	PROVIDES PATH FOR FULL POWER TO THE DC MOTOR FIELD WINDINGS BY BYPASSING RESISTOR RESC.	a. COILS FAILS OPEN	CONTACT REMAINS IN DE-ENERGIZED POSITION. THE DC MOTOR FIELD WILL BE WEAKENED. THIS WILL REDUCE THE TORQUE CAPABILITY OF THE DC MOTORS WHICH WILL CAUSE THE BRIDGE TO STOP WHEN A LOAD IS ON THE HOOK. DELAY OF OPERATIONS. SEE GROUND RULE I.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	THE DC MOTOR FIELD WILL BE WEAK- ENED. THIS WILL REDUCE THE TORQUE CAPABILITY OF THE DC MOTORS WHICH WILL CAUSE THE BRIDGE TO STOP WHEN A LOAD IS ON THE HOOK. DELAY OF OPERATIONS. SEE GROUND RULE I.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	THE DC MOTOR FIELD WILL REMAIN AT FULL STRENGTH.	NO EFFECT.	3

Table 42 (Page 2 of 3). ELECTRICAL FMEA - BRIDGE DRIVE						
System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
3FLA, 3FLB, 3FLC, 3FLD	RELAY	PROVIDES PROTECTION IF POWER TO THE DC MOTOR FIELD WINDINGS IS LOST. N.O. CONTACT WILL OPEN TO SHUT DOWN THE M-G SET.	a. COIL FAILS OPEN a. N.O. CONTACT FAILS OPEN a. N.O. CONTACT FAILS CLOSED	CONTACT WILL REMAIN IN DE-ENERGIZED POSITION. M-G SET WILL NOT RUN. DELAY OF OPERATION. M-G SET WILL NOT RUN. DELAY OF OPERATION. IF POWER IS LOST IN THE MOTOR FIELD WINDING CIRCUIT, THE CONTACTS FOR THE OTHER FIELD LOSS RELAYS WILL OPEN TO SHUT DOWN THE M-G SET. IF ONE MOTOR FIELD WINDING OPENS, THE REMAINING OPERATIONAL MOTORS CAN MOVE BRIDGE.	NO EFFECT. NO EFFECT. NO EFFECT.	3 3 3
RESA	RESISTOR	PROVIDES VOLTAGE DIVIDING CAPABILITY TO REDUCE THE VOLTAGE ACROSS TWO OF THE DC MOTOR FIELD WINDINGS.	a. FAIL OPEN	NO POWER TO THE FIELD WINDINGS. THE M-G SET WILL BE SHUT DOWN BY THE FIELD LOSS RELAYS. DELAY OF OPERATION.	NO EFFECT.	3
RESB	RESISTOR	PROVIDES VOLTAGE DIVIDING CAPABILITY TO REDUCE THE VOLTAGE ACROSS TWO OF THE DC MOTOR FIELD WINDINGS.	a. FAIL OPEN	NO POWER TO THE FIELD WINDINGS. THE M-G SET WILL BE SHUT DOWN BY THE FIELD LOSS RELAYS. DELAY OF OPERATION.	NO EFFECT.	3
RESC	RESISTOR	PROVIDES VOLTAGE DIVIDING CAPABILITY TO REDUCE THE VOLTAGE ACROSS ALL FOUR OF THE DC MOTOR FIELD WINDINGS PRIOR TO M-G SET START.	a. FAIL OPEN	NO POWER TO THE FIELD WINDINGS PRIOR TO M-G SET START. THE M-G SET CAN'T BE STARTED BECAUSE THE FIELD LOSS RELAYS WILL NOT BE ENERGIZED. DELAY OF OPERATION.	NO EFFECT.	3

Table 42 (Page 3 of 3). ELECTRICAL FMEA - BRIDGE DRIVE						
System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
RES D	RESISTOR	PROVIDES VOLTAGE DIVIDING CAPABILITY TO REDUCE THE VOLTAGE ACROSS TWO OF THE BRAKE SOLENOIDS.	a. FAIL OPEN	NO POWER TO THE BRAKE SOLENOIDS. BRAKES WILL NOT RELEASE WHEN THE MASTER CONTROLLER IS MOVED OUT OF NEUTRAL, OR THE BRAKE SWITCH IS ENGAGED, CAUSING POSSIBLE DAMAGE TO THE BRAKES. DELAY OF OPERATION.	NO EFFECT.	3
RESE	RESISTOR	PROVIDES VOLTAGE DIVIDING CAPABILITY TO REDUCE THE VOLTAGE ACROSS TWO OF THE BRAKE SOLENOIDS.	a. FAIL OPEN	NO POWER TO THE BRAKE SOLENOIDS. BRAKES WILL NOT RELEASE WHEN THE MASTER CONTROLLER IS MOVED OUT OF NEUTRAL, OR THE BRAKE SWITCH IS ENGAGED, CAUSING POSSIBLE DAMAGE TO THE BRAKES. DELAY OF OPERATION.	NO EFFECT.	3
1RES1	RESISTOR, THYRITE	MAINTAINS PREDETERMINED VOLTAGE CEILING ACROSS THE BRAKE SOLENOIDS. THIS WILL NOT CONDUCT UNTIL IT REACHES THE BREAKDOWN VOLTAGE AT WHICH TIME IT WILL CONDUCT AND KEEP THE BRAKE SOLENOIDS AT THE PROPER VOLTAGE.	a. FAIL OPEN	BRAKE SOLENOIDS MAY BE EXPOSED TO HIGHER VOLTAGES THAN EXPECTED. POSSIBLE DAMAGE TO THE SOLENOIDS.	NO EFFECT.	3
BR	BRAKE SOLENOID (1 OF 2)	WHEN THE COILS, CONTROLLED BY RELAY 3BR, ARE ENERGIZED, THE BRAKES WILL RELEASE.	a. COIL FAILS OPEN	BRAKES WILL NOT RELEASE WHEN THE MASTER CONTROLLER IS MOVED OUT OF NEUTRAL, OR THE BRAKE SWITCH IS ENGAGED, CAUSING POSSIBLE DAMAGE TO THE BRAKES. DELAY OF OPERATION.	NO EFFECT.	3

System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Sheet No. 12/21/22/24		Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 20, 21 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT		
3KRX	RELAY	PROVIDES PROTECTION AGAINST THE LOSS OF POWER TO THE GENERATOR FIELD DC INPUT CONTROLLER. RELAYS 3KR1, 3KR2, & 3KR3 MONITOR THIS POWER AND ENERGIZE THIS RELAY. THIS ENABLES THE BRIDGE CONTROLS IF THE POWER IS PRESENT AND IT DISABLES THE CONTROLS IF THE POWER IS NOT PRESENT.	a. COIL FAILS OPEN	CONTACT REMAINS IN DE-ENERGIZED POSITION. BRIDGE CONTROLS WILL REMAIN DISABLED. DELAY OF OPERATIONS.	NO EFFECT.	3		
			a. N.O. CONTACT FAILS OPEN	BRIDGE CONTROLS WILL REMAIN DISABLED. DELAY OF OPERATIONS.	NO EFFECT.	3		
			a. N.O. CONTACT FAILS CLOSED	LOSS OF ABILITY TO DISABLE THE BRIDGE CONTROLS IF POWER IS LOST TO ONE OF THE THREE RELAYS. MULTIPLE FAILURE REQUIRED.	NO EFFECT.	3		
3KR1	RELAY	MONITORS POWER SUPPLIED TO THE GENERATOR FIELD DC INPUT CONTROLLER DOWNSTREAM OF TRANSFORMER 3RT1. THE N.O. CONTACT IS ARRANGED IN SERIES WITH CONTACTS OF RELAYS 3KR2 & 3KR3 WHICH CLOSE TO ENERGIZE RELAY 3KRX.	a. COIL FAILS OPEN	CONTACT REMAINS IN DE-ENERGIZED POSITION. RELAY 3KRX WILL REMAIN DEENERGIZED. BRIDGE CONTROLS WILL REMAIN DISABLED. DELAY OF OPERATIONS.	NO EFFECT.	3		
			a. N.O. CONTACT FAILS OPEN	RELAY 3KRX WILL REMAIN DEENERGIZED. BRIDGE CONTROLS WILL REMAIN DISABLED. DELAY OF OPERATIONS.	NO EFFECT.	3		

Table 43 (Page 2 of 10). ELECTRICAL FMEA - BRIDGE DRIVE						
System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 20, 21 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
3KR2	RELAY	MONITORS POWER SUPPLIED TO THE GENERATOR FIELD DC INPUT CONTROLLER DOWN-STREAM OF TRANSFORMER 3RT1. THE N.O. CONTACT IS ARRANGED IN SERIES WITH CONTACTS OF RELAYS 3KR1 & 3KR3 WHICH CLOSE TO ENERGIZE RELAY 3KRX.	a. N.O. CONTACT FAILS CLOSED a. COIL FAILS OPEN	LOSS OF ABILITY TO DISABLE THE BRIDGE CONTROLS IF POWER FROM TRANSFORMER 3RT1 IS LOST. MULTIPLE FAILURE REQUIRED. CONTACT REMAINS IN DE-ENERGIZED POSITION. RELAY 3KRX WILL REMAIN DEENERGIZED. BRIDGE CONTROLS WILL REMAIN DISABLED. DELAY OF OPERATIONS.	NO EFFECT.	3
3KR3	RELAY	MONITORS POWER SUPPLIED TO THE GENERATOR FIELD DC INPUT CONTROLLER DOWN-STREAM OF TRANSFORMER 3RT2. THE N.O. CONTACT IS ARRANGED IN SERIES WITH CONTACTS OF RELAYS 3KR1 & 3KR2 WHICH CLOSE TO ENERGIZE RELAY 3KRX.	a. N.O. CONTACT FAILS OPEN a. N.O. CONTACT FAILS CLOSED a. COIL FAILS OPEN a. N.O. CONTACT FAILS OPEN	RELAY 3KRX WILL REMAIN DEENERGIZED. BRIDGE CONTROLS WILL REMAIN DISABLED. DELAY OF OPERATIONS. LOSS OF ABILITY TO DISABLE THE BRIDGE CONTROLS IF POWER FROM TRANSFORMER 3RT1 IS LOST. MULTIPLE FAILURE REQUIRED. CONTACT REMAINS IN DE-ENERGIZED POSITION. RELAY 3KRX WILL REMAIN DEENERGIZED. BRIDGE CONTROLS WILL REMAIN DISABLED. DELAY OF OPERATIONS. RELAY 3KRX WILL REMAIN DEENERGIZED. BRIDGE CONTROLS WILL REMAIN DISABLED. DELAY OF OPERATIONS.	NO EFFECT. NO EFFECT. NO EFFECT. NO EFFECT.	3 3 3

Table 43 (Page 3 of 10). ELECTRICAL FMEA - BRIDGE DRIVE						
System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 20, 21 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
3RF1, 3RF2	FUSE, 2.5A	PROVIDES PROTECTION AGAINST AN OVERCURRENT CONDITION UPSTREAM OF TRANSFORMER 3RT1.	a. N.O. CONTACT FAILS CLOSED	LOSS OF ABILITY TO DISABLE THE BRIDGE CONTROLS IF POWER FROM TRANSFORMER 3RT2 IS LOST. MUL- TIPLE FAILURE REQUIRED.	NO EFFECT.	3
			a. PREMATURE ACTUATION	RELAYS 3KR1, & 3KR2 WILL BE DEEN- ERGIZED WHICH WILL DISABLE THE BRIDGE CONTROLS. THE BRAKES WILL SET. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. FAILS TO ACTUATE	TRANSFORMER 3RT1 AND GENERATOR FIELD DC INPUT CONTROLLER MAY BE EXPOSED TO HIGHER THAN EXPECTED CURRENTS. POSSIBLE DAMAGE TO THESE COMPONENTS. MULTIPLE FAILURE REQUIRED.	NO EFFECT.	3
3RF3	FUSE, 5A	PROVIDES PROTECTION AGAINST AN OVERCURRENT CONDITION DOWNSTREAM OF TRANSFORMER 3RT1.	a. PREMATURE ACTUATION	RELAY 3KR1 WILL BE DEENERGIZED WHICH WILL DISABLE THE BRIDGE CONTROLS. THE BRAKES WILL SET. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. FAILS TO ACTUATE	GENERATOR FIELD DC INPUT CON- TROLLER MAY BE EXPOSED TO HIGHER THAN EXPECTED CURRENTS. POSSIBLE DAMAGE TO THIS COMPO- NENT. MULTIPLE FAILURE REQUIRED.	NO EFFECT.	3
3RF4	FUSE, 5A	PROVIDES PROTECTION AGAINST AN OVERCURRENT CONDITION DOWNSTREAM OF TRANSFORMER 3RT1.	a. PREMATURE ACTUATION	RELAY 3KR2 WILL BE DEENERGIZED WHICH WILL DISABLE THE BRIDGE CONTROLS. THE BRAKES WILL SET. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. FAILS TO ACTUATE	GENERATOR FIELD DC INPUT CON- TROLLER MAY BE EXPOSED TO HIGHER THAN EXPECTED CURRENTS. POSSIBLE DAMAGE TO THIS COMPO- NENT. MULTIPLE FAILURE REQUIRED.	NO EFFECT.	3

Table 43 (Page 4 of 10). ELECTRICAL FMEA - BRIDGE DRIVE						
System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 20, 21 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
3RF5, 3RF6	FUSE, .5A	PROVIDES PROTECTION AGAINST AN OVERCURRENT CONDITION UPSTREAM OF TRANSFORMER 3RT2.	a. PREMATURE ACTUATION a. FAILS TO ACTUATE	RELAY 3KR3 WILL BE DEENERGIZED WHICH WILL DISABLE THE BRIDGE CONTROLS. THE BRAKES WILL SET. DELAY OF OPERATIONS. TRANSFORMER 3RT2 AND GENERATOR FIELD DC INPUT CONTROLLER MAY BE EXPOSED TO HIGHER THAN EXPECTED CURRENTS. POSSIBLE DAMAGE TO THESE COMPONENTS. MULTIPLE FAILURE REQUIRED.	NO EFFECT. NO EFFECT.	3 3
3RF7, 3RF8	FUSE, .5A	PROVIDES PROTECTION AGAINST AN OVERCURRENT CONDITION DOWNSTREAM OF TRANSFORMER 3RT2.	a. PREMATURE ACTUATION a. FAILS TO ACTUATE	RELAY 3KR3 WILL BE DEENERGIZED WHICH WILL DISABLE THE BRIDGE CONTROLS. THE BRAKES WILL SET. DELAY OF OPERATIONS. GENERATOR FIELD DC INPUT CONTROLLER MAY BE EXPOSED TO HIGHER THAN EXPECTED CURRENTS. POSSIBLE DAMAGE TO THIS COMPONENT. MULTIPLE FAILURE REQUIRED.	NO EFFECT. NO EFFECT.	3 3
3RT1	ISOLATION TRANSFORMER	STEPS DOWN THE BUS VOLTAGE OF 480V TO THE DESIRED VOLTAGE OF 240V FOR USE IN THE GENERATOR FIELD DC INPUT CONTROLLER.	a. FAILS OPEN OR SHORT	LOSS OF POWER TO THE GENERATOR FIELD DC INPUT CONTROLLER. RELAYS 3KR1 & 3KR2 WILL BE DEENERGIZED TO DISABLE THE BRIDGE CONTROL CIRCUIT. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
3RT2	CONTROL TRANSFORMER	STEPS DOWN THE BUS VOLTAGE OF 480V TO THE DESIRED VOLTAGE OF 120V FOR USE IN THE GENERATOR FIELD DC INPUT CONTROLLER.	a. FAILS OPEN OR SHORT	LOSS OF POWER TO THE GENERATOR FIELD DC INPUT CONTROLLER. RELAY 3KR3 WILL BE DEENERGIZED TO DISABLE THE BRIDGE CONTROL CIRCUIT. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3

Table 43 (Page 5 of 10). ELECTRICAL FMEA - BRIDGE DRIVE						
System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 20, 21 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
3FC	GENERATOR FIELD DC INPUT CON- TROLLER	A SOLID STATE ASSEMBLY WHICH PROVIDES DC EXCITATION TO THE GENER- ATOR FIELD OF THE MOTOR-GENERATOR SET (M1-G1). THE EXCITATION IS PROPORTIONAL TO THE INPUT SUPPLIED FROM THE CONTROL POTENTIOMETER (RPOT) AND IS USED TO DRIVE THE DC MOTORS WHICH CONTROL THE BRIDGE.	a. NO OUTPUT	NO GENERATOR FIELD WINDING VOLTAGE. NO OUTPUT FROM THE GENERATOR. THE BRIDGE WILL NOT MOVE. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. HIGH OUTPUT (NOT INVERTED) b. BOARD COMPONENT SHORT, BOARD COMPO- NENT OPEN, LOSS OF VOLTAGE FEEDBACK FROM THE DC DRIVE MOTOR LOOP c. 09FY12-006.074 d. HIGH INDICATION OF CURRENT ON CONSOLE AMMETER, OR SPEED ON THE SELSYN e. BRING THE MASTER CONTROLLER TO NEUTRAL OR PRESS E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	INCREASE IN SPEED OF THE DC MOTORS CONTROLLING THE BRIDGE IN THE DIRECTION COMMANDED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2

Table 43 (Page 6 of 10). **ELECTRICAL FMEA - BRIDGE DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 20, 21 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
3XR	RELAY	ENABLES THE GENERATOR FIELD DC INPUT CONTROLLER SPEED REGULATOR, BI-DIRECTIONAL AMPLIFIER, AND FIRING CIRCUIT WHEN RELAY 3ECR OR 3WCR IS ENERGIZED, OR IF BRAKE SWITCH S1 IS ENGAGED.	a. HIGH OUTPUT (INVERTED) b. BOARD COMPONENT SHORT c. 09FY12-006.075 d. HIGH INDICATION OF CURRENT ON CONSOLE AMMETER, OR SPEED ON THE SELSYN e. BRING THE MASTER CONTROLLER TO NEUTRAL OR PRESS E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	INCREASE IN SPEED OF THE DC MOTORS CONTROLLING THE BRIDGE, IN THE OPPOSITE DIRECTION THAN COMMANDED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. NO GENERATOR FIELD DC INPUT CONTROLLER OUTPUT. NO GENERATOR FIELD WINDING VOLTAGE. NO OUTPUT FROM THE GENERATOR. THE BRIDGE WILL NOT MOVE. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN (1 OF 3)	NO GENERATOR FIELD DC INPUT CONTROLLER OUTPUT. NO GENERATOR FIELD WINDING VOLTAGE. NO OUTPUT FROM THE GENERATOR. THE BRIDGE WILL NOT MOVE. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED (1 OF 3)	THE GENERATOR FIELD DC INPUT CONTROLLER WILL REMAIN ENABLED. POSSIBLE DAMAGE TO THIS COMPONENT.	NO EFFECT.	3

System 175-TON BRIDGE CRANE, VAB
Subsystem BRIDGE DRIVE
Drawing No. 67-K-L-11348 Sheet No. 12/21/22/24
PMN K60-0528

Program SPACE SHUTTLE

Station Set/Facility Code TA
Date JULY 1993
Reference Figure Used 20, 21
Prepared By C. CRABB, LSOC 52-11

FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
3SYNT, 3SYNR	SYNCHRO TRANS- MITTER AND RECEIVER ASSEMBLY (SELSYN)	PROVIDES BRIDGE POSITION AND MOTION INDICATION TO THE OPERATOR IN CAB. THE OPERATOR USES THIS INDI- CATOR TO DETERMINE MOVE- MENT DISTANCE WHEN REQUIRED TO MAKE SMALL INCREMENTAL MOVES FOR MATE OPERATIONS. THERE ARE TWO TRANSMITTERS THAT CAN SUPPLY THIS INDI- CATION TO THE RECEIVER. THE TRANSMITTER TO BE USED HAS TO BE SELECTED BY A SWITCH EXTERNAL TO THE OPERATORS CAB.	a. ERRONEOUS OUTPUT (INDICATION) b. CORROSION, BINDING MECHANISM c. 09FY12-006.114 d. LOAD MOVEMENT NOT CORRESPONDING WITH CHANGE ON CONSOLE METER e. RETURN THE MASTER CONTROLLER TO NEUTRAL f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	LOSS OF ACCURATE POSITION INDI- CATION OR LOAD MOTION INDICATION COULD RESULT IN IMPROPER LOAD POSITIONING.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
3FOV	RELAY	PROTECTS AGAINST AN OVERVOLTAGE CONDITION IN THE DC MOTOR LOOP WHICH CAN RESULT IN A SPEED INCREASE OF THE BRIDGE. IT IS CONFIGURED TO SHUT DOWN THE M-G SET IF AN OVERVOLTAGE CONDITION (115% OF THE FULL FINE OUTPUT) IS DETECTED IN THE DC MOTOR LOOP WHILE IN THE FINE SPEED MODE.	a. COIL FAILS OPEN	N.O. CONTACT WILL REMAIN IN THE DE-ENERGIZED POSITION. BRIDGE M-G SET CANNOT BE STARTED. DELAY OF OPERATION.	NO EFFECT.	3
			a. COIL FAILS TO DEENER- GIZE	LOSS OF ABILITY TO SHUT DOWN THE M-G SET IF AN OVERVOLTAGE CONDI- TION EXISTS IN THE DC MOTOR LOOP. MULTIPLE FAILURE REQUIRED TO RESULT IN DAMAGE TO A VEHICLE SYSTEM.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	BRIDGE M-G SET CANNOT BE STARTED. DELAY OF OPERATION.	NO EFFECT.	3

Table 43 (Page 8 of 10). ELECTRICAL FMEA - BRIDGE DRIVE						
System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 20, 21 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
3FOV TRIP LIGHT	INDICATOR LIGHT	N.C. CONTACT CONTROLS POWER TO THE FOV TRIP LIGHT WHICH IS USED TO VERIFY PROPER OPERATION OF THIS RELAY DURING THE PRE-OPS CHECK.	a. N.O. CONTACT FAILS CLOSED	LOSS OF ABILITY TO SHUT DOWN THE M-G SET IF AN OVERVOLTAGE CONDI- TION EXISTS IN THE DC MOTOR LOOP. MULTIPLE FAILURE REQUIRED TO RESULT IN DAMAGE TO A VEHICLE SYSTEM.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	FOV TRIP LIGHT WILL NOT COME ON. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	FOV TRIP LIGHT WILL REMAIN ON. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAIL OPEN	FAILS TO INDICATE THE PROPER OPERATION OF THE FOV RELAY. DELAY OF OPERATION.	NO EFFECT.	3
3FOV RECT	RECTIFIER, BRIDGE	MAINTAINS A POSITIVE VOLTAGE INPUT TO RELAY 3FOV REGARDLESS OF THE VOLTAGE POLARITY AND CURRENT DIRECTION IN THE DC MOTOR LOOP.	a. DIODE FAILS OPEN/SHORTED	NO INPUT FROM THE DC MOTOR LOOP TO THE OVERVOLTAGE RELAY. LOSS OF ABILITY TO SHUT DOWN THE M-G SET IF AN OVERVOLTAGE CONDITION EXISTS IN THE DC MOTOR LOOP. MULTIPLE FAILURE REQUIRED TO RESULT IN DAMAGE TO A VEHICLE SYSTEM.	NO EFFECT.	3

Table 43 (Page 9 of 10). **ELECTRICAL FMEA - BRIDGE DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem BRIDGE DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 20, 21 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
3TDBC	RELAY, TIME DELAY	BYPASSES THE OVER- VOLTAGE RELAY, 3FOV, WHEN ENERGIZED BY POSITIONING THE SPEED SELECTOR SWITCH, SS3 TO COARSE SPEED. THE TIME DELAY IS SET TO PROVIDE TIME FOR THE VOLTAGE IN THE DC MOTOR LOOP TO GO BELOW THE 115% FULL FINE VOLTAGE THRESHOLD WHEN THE SPEED SELECTOR SWITCH IS POSITIONED FROM COARSE TO FINE SPEED WHILE THE CRANE IS IN MOTION. THIS PREVENTS INADVERTENT SHUT DOWNS OF THE M-G SET.	a. COIL FAILS OPEN	N.O. CONTACT WILL REMAIN IN THE DE-ENERGIZED POSITION AND WON'T BYPASS THE OVERVOLTAGE RELAY. IF THE CRANE IS OPERATING IN THE COARSE SPEED MODE, THE OVER- VOLTAGE RELAY WILL SHUT DOWN THE M-G SET WHEN THE VOLTAGE IN THE DC MOTOR LOOP REACHES 115% OF THE FULL FINE OUTPUT.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	THE OVERVOLTAGE RELAY WON'T BE BYPASSED. IF THE CRANE IS OPER- ATING IN THE COARSE SPEED MODE, THE OVERVOLTAGE RELAY WILL SHUT DOWN THE M-G SET WHEN THE VOLTAGE IN THE DC MOTOR LOOP REACHES 115% OF THE FULL FINE OUTPUT.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	THE OVERVOLTAGE RELAY WILL BE BYPASSED WHEN THE SPEED SELECTOR SWITCH IS IN THE FINE SPEED POSITION. MULTIPLE FAILURE REQUIRED TO RESULT IN DAMAGE TO A VEHICLE SYSTEM.	NO EFFECT.	3

System 175-TON BRIDGE CRANE, VAB
Subsystem BRIDGE DRIVE
Drawing No. 67-K-L-11348 Sheet No. 12/21/22/24
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Program SPACE SHUTTLE

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Prepared By C. CRABB, LSOC 52-11

FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
		N.O. CONTACT CLOSURES TO ILLUMINATE THE INDICATOR WHICH SHOWS THAT THE TIME DELAY RELAY IS ENERGIZED AND BYPASSING THE OVERVOLTAGE RELAY.	a. N.O. CONTACT FAILS OPEN	NO INDICATION THAT THE RELAY IS ENERGIZED. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	THE INDICATION THAT THE RELAY IS ENERGIZED WILL BE ILLUMINATED CONSTANTLY. DELAY OF OPERATION.	NO EFFECT.	3

Table 44 (Page 1 of 2). ELECTRICAL FMEA - TROLLEY DRIVE						
System 175-TON BRIDGE CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
			a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME		FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
FIND NO. PART NO.	PART NAME	PART FUNCTION		FAILURE EFFECT ON SYSTEM PERFORMANCE		
4CB	TROLLEY DRIVE CIRCUIT BREAKER, 350AT	PROVIDES OVERLOAD PROTECTION FOR THE TROLLEY CONTROL CIRCUITRY. CONTACT PROVIDES LATCHING FOR START RELAY 4SR.	a. PREMATURE TRIP a. FAIL TO TRIP a. N.O. CONTACT FAILS OPEN a. N.O. CONTACT FAILS CLOSED a. SHUNT TRIP FAILS OPEN	LOSS OF POWER TO THE TROLLEY DRIVE M.G. SET. BRAKES WILL SET. DELAY OF OPERATION. POSSIBLE DAMAGE TO THE TROLLEY CONTROL CIRCUITRY. UPSTREAM CB (MCB) MAY TRIP RESULTING IN LOSS OF POWER TO MAIN BUS. BRAKES WILL SET. DELAY OF OPERATIONS. M-G SET WILL NOT STAY RUNNING WHEN START BUTTON IS RELEASED. DELAY OF OPERATION. NO EFFECT ON STARTING OR RUNNING M-G SET. LOSS OF ABILITY TO SHUT DOWN THE TROLLEY BY THE PHASE REVERSAL RELAY. POSSIBLE DAMAGE TO THE CRANE CONTROL CIRCUITRY. MULTIPLE FAILURE REQUIRED.	NO EFFECT. NO EFFECT. NO EFFECT. NO EFFECT. NO EFFECT	3 3 3 3 3
OL1 OL2 OL3	OVERLOAD, THERMAL	PROVIDES THE ABILITY TO SHUT THE TROLLEY DOWN AND SET THE BRAKES WHEN THE SHUNT TRIP IS ENERGIZED BY THE PHASE REVERSAL RELAY. PROVIDES OVERLOAD PROTECTION IN EACH OF THE THREE LEGS OF THE MOTOR OF THE M-G SET. THREE N.C. CONTACTS, ARRANGED IN SERIES, OPEN TO SHUT DOWN THE M-G SET.	a. PREMATURE ACTUATION	SHUTDOWN OF THE M-G SET CAUSING THE TROLLEY TO STOP. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3

Table 44 (Page 2 of 2). ELECTRICAL FMEA - TROLLEY DRIVE						
System 175-TON BRIDGE CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
M6-G2	MOTOR-GENERATOR (M-G) SET, 30 HP-17KW	CONSISTS OF A 30-HP MOTOR COUPLED TO A 17KW DC GENERATOR TO PROVIDE POWER TO THE ARMATURES OF THE TWO 10-HP TROLLEY DRIVE MOTORS.	a. FAILS TO ACTUATE a. N.C. CONTACT FAILS CLOSED a. N.C. CONTACT FAILS OPEN a. NO OUTPUT	POSSIBLE DAMAGE TO THE MOTOR IN THE M-G SET. UPSTREAM CB (4CB) MAY TRIP, RESULTING IN LOSS OF POWER TO THE M-G SET. BRAKES WILL SET. DELAY OF OPERATION. BACKUP CONTACT IN SERIES WILL OPEN TO SHUT DOWN M-G SET. M-G WILL NOT RUN. DELAY OF OPERATION. LOSS OF POWER TO TROLLEY DRIVE MOTORS. DELAY OF OPERATION.	NO EFFECT. NO EFFECT. NO EFFECT. NO EFFECT.	3 3 3 3
M7, M8	MOTORS, 10 HP EACH	TWO SHUNT WOUND DC MOTORS. THE ARMATURES ARE ARRANGED IN SERIES TO PROVIDE MECHANICAL TORQUE TO DRIVE THE TROLLEY. THE FIELD WINDINGS PROVIDE A CONSTANT MAGNETIC FIELD TO WORK AGAINST THE VARYING MAGNETIC FIELD OF THE ARMATURE LOOP TO PRODUCE TORQUE.	a. OPEN ARMATURE WINDINGS a. OPEN FIELD WINDING	LOSS OF POWER TO THE DRIVE MOTORS. TROLLEY WILL NOT MOVE. DELAY OF OPERATION. RELAY 4FLA, OR 4FLB WILL BE DE-ENERGIZED AND OPEN THE CONTACTS TO SHUT DOWN M-G SET. DELAY OF OPERATION.	NO EFFECT. NO EFFECT.	3 3

Table 45 (Page 1 of 4). ELECTRICAL FMEA - TROLLEY DRIVE						
System 175-TON BRIDGE CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
40S1	M-G OVER- SPEED SENSOR	PROVIDES CAPABILITY TO SHUT DOWN THE M-G SET IF AN OVERSPEED CONDITION EXISTS.	a. N.C. CONTACT FAILS CLOSED	LOSS OF M-G OVERSPEED PRO- TECTION. POSSIBLE DAMAGE TO THE M-G SET WHEN COUPLED WITH M-G OVERSPEED.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	UNABLE TO START M-G SET. DELAY OF OPERATION.	NO EFFECT.	3
OTG	GENERATOR OVERTEM- PERATURE SENSOR	PROVIDES CAPABILITY TO SHUT DOWN THE M-G SET IF AN OVERTEMPERATURE CON- DITION EXISTS.	a. N.C. CONTACT FAILS CLOSED	LOSS OF GENERATOR OVERTEMPER- ATURE PROTECTION. POSSIBLE DAMAGE TO THE M-G SET WHEN COUPLED WITH GENERATOR OVER- TEMPERATURE CONDITION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	UNABLE TO START M-G SET. DELAY OF OPERATION.	NO EFFECT.	3
4CCB	CIRCUIT BREAKER, 30AT	PROVIDES OVERLOAD PRO- TECTION FOR CIRCUIT PRO- VIDING POWER TO TROLLEY DRIVE M-G SET.	a. PREMATURE TRIP	LOSS OF POWER TO TROLLEY DRIVE STARTER CONTROLS. TROLLEY DRIVE WILL STOP. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAILS TO TRIP	POSSIBLE DAMAGE TO THE TROLLEY CONTROL CIRCUITRY. UPSTREAM CB (4CB) MAY TRIP. LOSS OF POWER TO TROLLEY DRIVE M-G SET. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
4TR	RELAY, TIME DELAY	PROVIDES TIMED DELAY FOR DROPPING OUT THE START CIRCUIT AND PICKING UP THE RUN CIRCUIT FOR THE TROLLEY DRIVE M-G SET.	a. COIL FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. M-G SET WILL NOT GET FULL POWER. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	M-G SET WILL NOT GET FULL POWER. DELAY OF OPERATION.	NO EFFECT.	3

Table 45 (Page 2 of 4). **ELECTRICAL FMEA - TROLLEY DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 Sheet No. 25/26/27 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
4Y	RELAY	CONTROLS STARTING CURRENT FOR TROLLEY DRIVE M-G SET.	a. N.O. CONTACT FAILS CLOSED	M-G SET WILL GET FULL POWER WHEN START BUTTON IS PUSHED, POSSIBLY CAUSING CURRENT OVERLOAD TO TRIP. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	M-G SET WILL NOT GET FULL POWER. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	M-G SET WILL GET FULL POWER WHEN START BUTTON IS PUSHED, POSSIBLY CAUSING CURRENT OVERLOAD TO TRIP. DELAY OF OPERATION.	NO EFFECT.	3
			a. COIL FAILS OPEN	CONTACT WILL REMAIN IN DE-ENERGIZED POSITION. M-G SET WILL NOT START PROPERLY. EXCES- SIVE START-UP CURRENT TO M-G SET, THROUGH RELAY CONTACT 4R (RUN RELAY), WOULD CAUSE M-G SET OVERLOADS TO TRIP. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN (1 OF 2)	M-G SET WILL NOT START PROPERLY. EXCESSIVE START-UP CURRENT TO M-G SET, THROUGH RELAY CONTACT 4R (RUN RELAY), WOULD CAUSE M-G SET OVERLOADS TO TRIP. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED (1 OF 2)	CURRENT WILL BYPASS THIS PORTION OF THE CIRCUIT THROUGH RELAY CONTACT 4R (RUN RELAY). NO EFFECT ON CRANE OPERATION. RELAY CONTACT 4S WILL OPEN TO REMOVE POWER FROM THE START CIRCUIT.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	NO EFFECT ON STARTING OR RUNNING OF M-G SET.	NO EFFECT.	3

Table 45 (Page 3 of 4). ELECTRICAL FMEA - TROLLEY DRIVE						
System 175-TON BRIDGE CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
4S	RELAY	ENERGIZES WHEN THE M-G SET IS STARTED TO PROVIDE LATCHING FOR RELAY 4SR (START RELAY). THIS ALSO CONTROLS THE STARTING CURRENT FOR THE TROLLEY M-G SET.	a. N.C. CONTACT FAILS OPEN	M-G SET WOULD NOT GET FULL POWER. DELAY OF OPERATION.	NO EFFECT.	3
			a. COIL FAILS OPEN	CONTACT WILL REMAIN IN DE-ENERGIZED POSITION. M-G SET WILL NOT START.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	M-G SET SHUTS OFF AFTER THE START BUTTON IS LET UP. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	M-G SET WILL RESTART AFTER THE STOP BUTTON IS RELEASED. THE POWER CAN BE REMOVED BY OPENING CIRCUIT BREAKER 4CB. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	M-G SET WILL NOT START PROPERLY. EXCESSIVE START-UP CURRENT TO M-G SET, THROUGH RELAY CONTACT 4R (RUN RELAY), WOULD CAUSE M-G SET OVERLOADS TO TRIP. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	CURRENT WILL BYPASS THIS PORTION OF THE CIRCUIT THROUGH RELAY CONTACT 3R (RUN RELAY). NO EFFECT ON CRANE OPERATION. IF ALL THREE CONTACTS ARE HELD CLOSED THE M-G SET WILL CONTINUE TO RUN AT A REDUCED VOLTAGE WHEN COMMANDED TO STOP. DELAY OF OPERATIONS.	NO EFFECT.	3

Table 45 (Page 4 of 4). ELECTRICAL FMEA - TROLLEY DRIVE						
System 175-TON BRIDGE CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
4R	RELAY	CONTROLS RUNNING CURRENT TO TROLLEY DRIVE M-G SET.	a. COIL FAILS OPEN a. N.O. CONTACT FAILS CLOSED a. N.O. CONTACT FAILS OPEN a. N.C. CONTACT FAILS CLOSED a. N.C. CONTACT FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. M-G SET WILL NOT GET FULL POWER. DELAY OF OPERATION. IF JUST ONE CONTACT IS HELD CLOSED IT COULD CAUSE AN EXCESSIVE START CURRENT WHICH WOULD TRIP M-G SET OVERLOADS. DELAY OF OPERATIONS. OR IF ALL THREE CONTACTS ARE HELD CLOSED THE M-G SET WILL CONTINUE TO RUN WHEN COMMANDED TO STOP. DELAY OF OPERATIONS. MOTOR WOULD NOT GET THE PROPER RUN CURRENT. M-G SET WILL NOT RECEIVE FULL POWER. DELAY OF OPERATION. RELAY 4Y WILL BE DEENERGIZED BY SERIES ARRANGED CONTACT OF 4TR. NO EFFECT ON STARTING OR RUNNING OPERATIONS. M-G SET WILL NOT START PROPERLY. EXCESSIVE START-UP CURRENT TO M-G SET WOULD CAUSE M-G SET OVERLOADS TO TRIP. DELAY OF OPERATION.	NO EFFECT. NO EFFECT. NO EFFECT. NO EFFECT. NO EFFECT.	3 3 3 3 3
4L1A, 4L2A, 4L3A	AUTOTRANS- FORMER	REGULATES THE STARTING VOLTAGE FOR MOTOR M6 IN THE M-G SET. (1 PER PHASE LEG, 3 TOTAL).	a. FAILS OPEN	MOTOR M6 WILL NOT GET THE PROPER STARTING VOLTAGE. POSSIBLE DAMAGE TO THE M-G SET. DELAY OF OPERATIONS.	NO EFFECT.	3

Table 46 (Page 1 of 18). ELECTRICAL FMEA - TROLLEY DRIVE						
System 175-TON TROLLEY CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 Sheet No. 12/25/26/27/28 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
4-OTT	AUTOTRANS- FORMER OVERTEM- PERATURE SENSOR	PROVIDES CAPABILITY TO SHUT DOWN TROLLEY DRIVE M-G SET IF AUTOTRANSFORMER OVER- HEATS.	a. N.C. CONTACT FAILS CLOSED	POSSIBLE DAMAGE TO THE M-G SET. MULTIPLE FAILURE REQUIRED. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	M-G SET WILL NOT START. DELAY OF OPERATION.	NO EFFECT.	3
4TR1	CONTROL TRANS- FORMER	STEPS DOWN THE BUS VOLTAGE OF 480V TO THE DESIRED CONTROL VOLTAGE OF 120V FOR MAIN CONTROL POWER FOR THE TROLLEY DRIVE.	a. FAILS OPEN OR SHORT	LOSS OF CONTROL POWER. TROLLEY DRIVE M-G SET WILL STOP. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
4CCB1	TROLLEY DRIVE CONTROL POWER CIRCUIT BREAKER, 15AT	PROVIDES OVERLOAD PRO- TECTION FOR CIRCUIT FUR- NISHING CONTROL POWER FOR THE TROLLEY DRIVE.	a. PREMATURE TRIP	LOSS OF CONTROL POWER TO TROLLEY DRIVE. M-G SET WILL STOP. BRAKES WILL SET. DELAY OF OPERA- TION.	NO EFFECT.	3
			a. FAILS TO TRIP	POSSIBLE DAMAGE TO CONTROL CIR- CUITRY. MULTIPLE FAILURE REQUIRED. UPSTREAM CB 4CCB MAY TRIP RESULTING IN LOSS OF POWER TO STARTING AND CONTROL CIR- CUITS. M-G SET WILL STOP. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
S3	PUSH-BUTTON SWITCH, START AND STOP	PROVIDES POWER TO THE TROLLEY DRIVE START RELAY 4SR TO START AND STOP THE M-G SET.	a. START SWITCH FAILS OPEN	UNABLE TO START M-G SET. DELAY OF OPERATION.	NO EFFECT.	3

Table 46 (Page 2 of 18). ELECTRICAL FMEA - TROLLEY DRIVE						
System 175-TON TROLLEY CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
PL29	INDICATION LAMP	PROVIDES INDICATION THAT TROLLEY DRIVE M-G SET STARTING RELAY IS ENER- GIZED.	a. START SWITCH FAILS CLOSED	M-G SET WILL RESTART AFTER IT HAS BEEN SHUT DOWN WITH STOP BUTTON. M-G SET CAN BE SHUT DOWN BY OPENING CB 4CCB OR 4CCB1.	NO EFFECT.	3
			a. STOP SWITCH FAILS CLOSED	UNABLE TO SHUT DOWN M-G SET WITH S3. M-G SET CAN BE SHUT DOWN BY OPENING CB 4CCB OR 4CCB1.	NO EFFECT.	3
			a. STOP SWITCH FAILS OPEN	UNABLE TO START M-G SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAILS OPEN	UNABLE TO DETERMINE IF STARTING RELAY IS ENERGIZED. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAILS SHORT	UNABLE TO ENERGIZE STARTING RELAY. DELAY OF OPERATION.	NO EFFECT.	3
4SR	RELAY	ENABLES THE TROLLEY CONTROL CIRCUITRY.	a. COIL FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. UNABLE TO START M-G SET. DELAY OF OPERA- TION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	M-G SET WILL START BUT THE TROLLEY CANNOT BE MOVED, AND THE BRAKES CANNOT BE RELEASED WITH 4MC. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	LOSS OF ABILITY TO DISABLE 4MC WITH 3SR. SERIES ARRANGED N.O. RELAY CONTACT OF 4KRX, WILL DISABLE 4MC.	NO EFFECT.	3

Table 46 (Page 3 of 18). ELECTRICAL FMEA - TROLLEY DRIVE						
System 175-TON TROLLEY CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
4MC	MASTER CONTROL SWITCH	N.O. CONTACT CLOSURES TO INITIATE AND MAINTAIN THE START AND RUN SEQUENCE FOR THE TROLLEY M-G SET.	a. N.O. CONTACT FAILS OPEN	M-G SET WILL NOT START. DELAY OF OPERATION.	NO EFFECT.	3
		A "JOYSTICK" CONNECTED TO MECHANICAL CONTACTS (4MC-2 & 4MC-3) AND REFERENCE POTENTIOMETER (RPOT), TO PROVIDE THE OPERATOR CONTROL OF THE TROLLEY TRAVEL IN THE EAST/WEST DIRECTION.	a. N.O. CONTACT FAILS CLOSED	UNABLE TO SHUT DOWN M-G SET WITH STOP BUTTON. M-G SET CAN BE SHUT DOWN BY OPENING CIRCUIT BREAKER 3CCB.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN (1 OF 2)	UNABLE TO DRIVE THE TROLLEY MOTORS AND RELEASE THE BRAKES FOR NORMAL OPERATIONS. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED (1 OF 2)	BRAKES WILL NOT SET WHEN THE MASTER CONTROL LEVER IS RETURNED TO THE NEUTRAL POSITION. WITH RPOT CENTERED THERE WILL BE NO INPUT TO THE DC MOTORS AND THE TROLLEY WILL STOP.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	UNABLE TO START THE M-G SET. DELAY OF OPERATION.	NO EFFECT.	3
		N.C. CONTACT (4MCS) OPENS WHEN THE "JOYSTICK" IS POSITIONED OUT OF DETENT TO PREVENT THE M-G SET FROM BEING STARTED.	a. N.C. CONTACT FAILS CLOSED	M-G SET CAN BE STARTED WITH THE "JOYSTICK" OUT OF DETENT. OPERATOR ERROR REQUIRED.	NO EFFECT.	3

Table 46 (Page 4 of 18). ELECTRICAL FMEA - TROLLEY DRIVE						
System 175-TON TROLLEY CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
4NCR	RELAY	CONTROLS POWER TO BRAKE RELAY, 4BR, TO RELEASE THE BRAKES DURING TROLLEY TRAVEL.	a. COIL FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. BRAKES WILL NOT RELEASE WHEN THE MASTER CONTROLLER IS MOVED OUT OF NEUTRAL, AND THE BRAKE SWITCH IS NOT ENGAGED, CAUSING POSSIBLE DAMAGE TO THE BRAKES. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	BRAKES WILL NOT RELEASE WHEN THE MASTER CONTROLLER IS MOVED OUT OF NEUTRAL, AND THE BRAKE SWITCH IS NOT ENGAGED, CAUSING POSSIBLE DAMAGE TO THE BRAKES. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	BRAKES WILL NOT SET WHEN THE MASTER CONTROL LEVER IS RETURNED TO THE NEUTRAL POSITION. WITH RPOT CENTERED THERE WILL BE NO INPUT TO THE DC MOTORS AND THE TROLLEY WILL STOP.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	RELAY 3SCR WILL NOT BE LOCKED OUT.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	UNABLE TO TRAVEL IN OPPOSITE DIRECTION. DELAY OF OPERATION.	NO EFFECT.	3
4SCR	RELAY	CONTROLS POWER TO BRAKE RELAY, 4BR, TO RELEASE THE BRAKES DURING TROLLEY TRAVEL.	a. COIL FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. BRAKES WILL NOT RELEASE WHEN THE MASTER CONTROLLER IS MOVED OUT OF NEUTRAL, AND THE BRAKE SWITCH IS NOT ENGAGED, CAUSING POSSIBLE DAMAGE TO THE BRAKES. DELAY OF OPERATION.	NO EFFECT.	3

Table 46 (Page 5 of 18). **ELECTRICAL FMEA - TROLLEY DRIVE**

System 175-TON TROLLEY CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 Sheet No. 12/25/26/27/28 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
4NLS 4SLS	END TRAVEL LIMIT SWITCH	SETS THE BRAKES ON THE TROLLEY DRIVE IN THE EVENT THE END LIMIT OF TRAVEL IS REACHED.	a. N.O. CONTACT FAILS OPEN	BRAKES WILL NOT RELEASE WHEN THE MASTER CONTROLLER IS MOVED OUT OF NEUTRAL, AND THE BRAKE SWITCH IS NOT ENGAGED, CAUSING POSSIBLE DAMAGE TO THE BRAKES. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	BRAKES WILL NOT SET WHEN THE MASTER CONTROL LEVER IS RETURNED TO THE NEUTRAL POSI- TION. WITH RPOT CENTERED THERE WILL BE NO INPUT TO THE DC MOTORS AND THE TROLLEY WILL STOP.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	RELAY 3NCR WILL NOT BE LOCKED OUT.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	UNABLE TO TRAVEL IN OPPOSITE DIRECTION. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. FAILS OPEN	BRAKES WILL NOT RELEASE UNLESS THE BRAKE SWITCH IS ENGAGED, CAUSING POSSIBLE DAMAGE TO THE BRAKES. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. FAILS CLOSED	POSSIBLE DAMAGE TO THE TROLLEY STRUCTURE. MULTIPLE FAILURE OR OPERATOR ERROR REQUIRED.	NO EFFECT.	3
HCR RUN	RELAY	CONTROLS RELAY 4RUN FOR ENERGIZING THE GENERATOR FIELD WINDING FOR TROLLEY TRAVEL.	a. COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. THE GENERATOR FIELD WINDING WILL NOT BE ENERGIZED. NO OUTPUT FROM GENERATOR. UNABLE TO MOVE TROLLEY. DELAY OF OPERATION.	NO EFFECT.	3

Table 46 (Page 6 of 18). ELECTRICAL FMEA - TROLLEY DRIVE						
System 175-TON TROLLEY CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
		N.O. CONTACT, ARRANGED IN SERIES WITH 4VR, CLOSES TO PROVIDE SELF LATCHING AND KEEP RELAY 4NCR ENERGIZED TO PROVIDE FOR A SMOOTH SLOW TO STOP MOVEMENT BY KEEPING THE BRAKES RELEASED UNTIL THE VOLTAGE IN THE DC MOTOR LOOP GOES BELOW A PREDETERMINED LIMIT.	a. N.O. CONTACT FAILS OPEN	THE GENERATOR FIELD WINDING WILL NOT BE ENERGIZED. NO OUTPUT FROM GENERATOR. UNABLE TO MOVE TROLLEY. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	RELAY 4RUN N.O. CONTACT WILL REMAIN CLOSED WHEN THE JOYSTICK IS RETURNED TO CENTER. THERE WILL BE NO INPUT TO THE GENERATOR FIELD WINDING BECAUSE THE GENERATOR FIELD DC INPUT CONTROLLER WILL BE DISABLED.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	THE GENERATOR FIELD WINDING WILL NOT BE ENERGIZED. NO OUTPUT FROM GENERATOR. UNABLE TO MOVE TROLLEY. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	RELAY 4RUN N.O. CONTACT WILL DROP OUT (OPEN) BY GRAVITY AND/OR THE SPRING FORCE.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	BRAKES WILL SET IMMEDIATELY WHEN THE JOYSTICK IS RETURNED TO NEUTRAL. POSSIBLE DAMAGE TO THE BRAKES.	NO EFFECT.	3

Table 46 (Page 7 of 18). ELECTRICAL FMEA - TROLLEY DRIVE						
System 175-TON TROLLEY CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
LCR RUN	RELAY	CONTROLS RELAY 4RUN FOR ENERGIZING THE GENERATOR FIELD WINDING FOR TROLLEY TRAVEL.	a. N.O. CONTACT FAILS CLOSED	SERIES ARRANGED CONTACT OF RELAY 4VR WILL OPEN WHEN THE VOLTAGE IN THE DC MOTOR GOES BELOW THE PREDETERMINED LEVEL TO DEENERGIZE RELAYS HCR RUN AND 4NCR. THE VOLTAGE IN THE DC MOTOR LOOP WILL DECREASE WHEN THE JOYSTICK IS RETURNED TO NEUTRAL.	NO EFFECT.	3
			a. COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. THE GENERATOR FIELD WINDING WILL NOT BE ENERGIZED. NO OUTPUT FROM GENERATOR. UNABLE TO MOVE TROLLEY. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	THE GENERATOR FIELD WINDING WILL NOT BE ENERGIZED. NO OUTPUT FROM GENERATOR. UNABLE TO MOVE TROLLEY. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	RELAY 4RUN N.O. CONTACT WILL REMAIN CLOSED WHEN THE JOYSTICK IS RETURNED TO CENTER. THERE WILL BE NO INPUT TO THE GENER- ATOR FIELD WINDING BECAUSE THE GENERATOR FIELD DC INPUT CON- TROLLER WILL BE DISABLED.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	THE GENERATOR FIELD WINDING WILL NOT BE ENERGIZED. NO OUTPUT FROM GENERATOR. UNABLE TO MOVE TROLLEY. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	RELAY 4RUN N.O. CONTACT WILL DROP OUT (OPEN) BY GRAVITY AND/OR THE SPRING FORCE.	NO EFFECT.	3

Table 46 (Page 8 of 18). ELECTRICAL FMEA - TROLLEY DRIVE						
System 175-TON TROLLEY CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
			a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME		FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
FIND NO. PART NO.	PART NAME	PART FUNCTION		FAILURE EFFECT ON SYSTEM PERFORMANCE		
S1	BRAKE SWITCH	N.O. CONTACT, ARRANGED IN SERIES WITH 4VR, CLOSSES TO PROVIDE SELF LATCHING AND KEEP RELAY 4SCR ENERGIZED TO PROVIDE FOR A SMOOTH SLOW TO STOP MOVEMENT BY KEEPING THE BRAKES RELEASED UNTIL THE VOLTAGE IN THE DC MOTOR LOOP GOES BELOW A PREDETERMINED LIMIT.	a. N.O. CONTACT FAILS OPEN	BRAKES WILL SET IMMEDIATELY WHEN THE JOYSTICK IS RETURNED TO NEUTRAL. POSSIBLE DAMAGE TO THE BRAKES.	NO EFFECT.	3
		PROVIDES CAPABILITY TO RELEASE BRAKES WHILE MASTER CONTROL SWITCH IS IN NEUTRAL POSITION.	a. N.O. CONTACT FAILS CLOSED	SERIES ARRANGED CONTACT OF RELAY 4VR WILL OPEN WHEN THE VOLTAGE IN THE DC MOTOR GOES BELOW THE PREDETERMINED LEVEL TO DEENERGIZE RELAYS LCR RUN AND 4SCR. THE VOLTAGE IN THE DC MOTOR LOOP WILL DECREASE WHEN THE JOYSTICK IS RETURNED TO NEUTRAL.	NO EFFECT.	3
			a. FAILS OPEN	UNABLE TO RELEASE BRAKES WHILE MASTER CONTROL SWITCH IS IN NEUTRAL POSITION.	NO EFFECT.	3
			a. FAILS CLOSED	BRAKES WILL BE RELEASED WHILE THE MASTER CONTROL SWITCH IS IN THE NEUTRAL POSITION. WITH THE MASTER CONTROL SWITCH CENTERED THERE WILL BE NO INPUT TO THE DC MOTORS AND THE TROLLEY WILL STOP.	NO EFFECT.	3

Table 46 (Page 10 of 18). ELECTRICAL FMEA - TROLLEY DRIVE						
System 175-TON TROLLEY CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
4RUN	RELAY	N.O. CONTACT CLOSES TO ALLOW INPUT CURRENT FROM THE GENERATOR FIELD DC INPUT CONTROLLER TO THE M-G SET GENERATOR FIELD WINDING TO MOVE THE DC DRIVE MOTORS. N.C. CONTACT ALLOWS RESIDUAL CURRENT IN THE GENERATOR TO DIMINISH AFTER THE DRIVE MOTION IS COMPLETED.	a. "PULL IN" COIL FAILS OPEN a. "DROP OUT" COIL FAILS OPEN. a. N.O. CONTACT FAILS OPEN/N.C. CONTACT FAILS CLOSED a. N.O. CONTACT FAILS CLOSED/N.C. CONTACT FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. GENERATOR FIELD WINDING WILL NOT BE ENERGIZED. NO OUTPUT FROM GENERATOR. DELAY OF OPERATION. THE N.O. CONTACT WILL DROP OUT (OPEN) BY GRAVITY AND/OR THE SPRING FORCE. GENERATOR FIELD WILL NOT BE ENERGIZED. NO OUTPUT FROM GENERATOR. DELAY OF OPERATION. N.O. CONTACT WILL REMAIN CLOSED WHEN THE JOYSTICK IS RETURNED TO CENTER. THERE WILL BE NO INPUT TO THE GENERATOR FIELD WINDING BECAUSE THE GENERATOR FIELD DC INPUT CONTROLLER WILL BE DISABLED.	NO EFFECT. NO EFFECT. NO EFFECT. NO EFFECT.	3 3 3 3
5RES	RESISTOR	PROVIDES A CURRENT LIMITER FOR THE RESIDUAL CURRENT IN THE GENERATOR AFTER THE DRIVE MOTION IS COMPLETED.	a. FAILS OPEN	THE RESIDUAL CURRENT IN THE GENERATOR WILL NOT BE DIMINISHED. NO EFFECT ON NORMAL OPERATIONS.	NO EFFECT.	3
PL30	INDICATION LAMP	PROVIDES INDICATION THAT TROLLEY DRIVE MOTOR #1 IS OVERHEATING.	a. FAILS OPEN	NO INDICATION FOR MOTOR OVERHEATING FROM LIGHT. ALARM WILL SOUND.	NO EFFECT.	3

Table 46 (Page 11 of 18). ELECTRICAL FMEA - TROLLEY DRIVE						
System 175-TON TROLLEY CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
PL31	INDICATION LAMP	PROVIDES INDICATION THAT TROLLEY DRIVE MOTOR #2 IS OVERHEATING.	a. FAILS OPEN	NO INDICATION FOR MOTOR OVERHEATING FROM LIGHT. ALARM WILL SOUND.	NO EFFECT.	3
PL32	INDICATION LAMP	PROVIDES INDICATION THAT TROLLEY DRIVE BLOWER MOTOR #1 IS OVERHEATING.	a. FAILS OPEN	NO INDICATION FOR BLOWER MOTOR OVERHEATING FROM LIGHT.	NO EFFECT.	3
PL33	INDICATION LAMP	PROVIDES INDICATION THAT TROLLEY DRIVE BLOWER MOTOR #2 IS OVERHEATING.	a. FAILS OPEN	NO INDICATION FOR BLOWER MOTOR OVERHEATING FROM LIGHT.	NO EFFECT.	3
4MB	RELAY	ENERGIZES TO TURN ON BLOWER MOTORS, M21 & M22, WHEN THE M-G SET IS STARTED.	a. COIL FAILS OPEN	CONTACTS REMAIN IN DEENERGIZED POSITION. THE BLOWER MOTORS WILL NOT START. POSSIBLE DAMAGE TO THE DC DRIVE MOTORS. THE TROLLEY MOTOR WINDING TEMPERATURE SENSOR WILL SHUT DOWN THE TROLLEY M-G SET IF NECESSARY.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN (1 OF 3)	BLOWER MOTORS WILL NOT RECEIVE FULL POWER. POSSIBLE DAMAGE TO THE BLOWER MOTORS AND THE DC DRIVE MOTORS. THE TROLLEY MOTOR WINDING TEMPERATURE SENSOR WILL SHUT DOWN THE TROLLEY M-G SET IF NECESSARY.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED (1 OF 3)	BLOWER MOTORS WILL BE SHUT OFF AS EXPECTED.	NO EFFECT.	3

Table 46 (Page 12 of 18). ELECTRICAL FMEA - TROLLEY DRIVE						
System 175-TON TROLLEY CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
4OLR1, 4OLR2	RELAY	RELAYS ENERGIZE TO ENABLE THE BLOWER MOTOR START RELAY 4MB. PRO- VIDES CAPABILITY TO SHUT DOWN ALL BLOWER MOTORS AND LIGHT BLOWER MOTOR OVERHEATING INDICATOR LIGHTS WHEN DEENERGIZED BY ONE OF THE BLOWER MOTOR OVERLOADS.	a. COIL FAILS OPEN	CONTACTS REMAIN IN DEENERGIZED POSITION. THE BLOWER MOTORS WILL NOT START. BLOWER MOTOR OVERHEATING INDICATION LIGHT WILL REMAIN ON. DELAY OF OPERA- TION.	NO EFFECT	3
			a. N.C. CONTACT FAILS CLOSED	BLOWER MOTOR OVERHEATING INDI- CATION LIGHT WILL REMAIN ON. DELAY OF OPERATION.	NO EFFECT	3
			a. N.C. CONTACT FAILS OPEN	BLOWER MOTOR OVERHEATING INDI- CATION LIGHT WILL NOT COME ON IF AN OVERHEAT OCCURS. THE BLOWER MOTOR WILL BE SHUT DOWN BY THE N.O. CONTACT. THE TROLLEY MOTOR WINDING TEMPERATURE SENSOR WILL SHUT DOWN THE TROLLEY M-G SET IF NECESSARY.	NO EFFECT	3
			a. N.O. CONTACT FAILS OPEN	THE BLOWER MOTORS WILL NOT START. POSSIBLE DAMAGE TO THE DC DRIVE MOTORS. THE TROLLEY MOTOR WINDING TEMPERATURE SENSOR WILL SHUT DOWN THE TROLLEY M-G SET IF NECESSARY.	NO EFFECT	3
			a. N.O. CONTACT FAILS CLOSED	SERIES ARRANGED CONTACTS WILL OPEN TO SHUT DOWN THE BLOWER MOTORS.	NO EFFECT	3
4ACR	RELAY	PROVIDES POWER TO ACTI- VATE MOTOR OVERHEATING ALARM.	a. COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. OVERHEATING ALARM WILL NOT SOUND. NO EFFECT ON THE INDICATOR LIGHT.	NO EFFECT.	3

Table 46 (Page 13 of 18). ELECTRICAL FMEA - TROLLEY DRIVE						
System 175-TON TROLLEY CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
D9	DIODE	PREVENTS TROLLEY MOTOR #1 OVERHEATING INDICATOR FROM COMING ON WHILE ALARM RELAY, 4ACR, IS ENERGIZED WHEN MOTOR #2 OVERHEATS.	a. N.O. CONTACT FAILS OPEN	OVERHEATING ALARM WILL NOT SOUND. NO EFFECT ON THE INDICATOR LIGHT.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	OVERHEATING ALARM WILL SOUND INADVERTENTLY. DELAY OF OPERATION	NO EFFECT.	3
			a. FAILS OPEN	ALARM WILL NOT SOUND WHEN MOTOR #1 OVERHEATS. INDICATION LIGHT WILL SIGNAL OPERATOR OF OVERHEAT CONDITION.	NO EFFECT.	3
			a. FAILS SHORT	TROLLEY MOTOR #1 OVERHEAT INDICATOR WILL COME ON WHEN MOTOR #2 OVERHEATS. ALARM MAY NOT SOUND.	NO EFFECT.	3
D10	DIODE	PREVENTS TROLLEY MOTOR #2 OVERHEATING INDICATOR FROM COMING ON WHILE ALARM RELAY, 4ACR, IS ENERGIZED WHEN MOTOR #1 OVERHEATS.	a. FAILS OPEN	ALARM WILL NOT SOUND WHEN MOTOR #2 OVERHEATS. INDICATION LIGHT WILL SIGNAL OPERATOR OF OVERHEAT CONDITION.	NO EFFECT.	3
			a. FAILS SHORT	TROLLEY MOTOR #2 OVERHEAT INDICATOR WILL COME ON WHEN MOTOR #1 OVERHEATS. ALARM MAY NOT SOUND.	NO EFFECT.	3

Table 46 (Page 14 of 18). ELECTRICAL FMEA - TROLLEY DRIVE						
System 175-TON TROLLEY CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
4K1	RELAY	OVERHEATING TEMPERATURE SENSING RELAY IS ACTUATED WHEN A THERMISTOR IN THE WINDINGS OF TROLLEY MOTOR #1 REACHES A PREDETERMINED TEMPERATURE. THE CONTACTS CLOSE TO SOUND ALARM AND TURN ON OVERHEATING INDICATOR LIGHT.	a. THERMISTOR COIL FAILS OPEN	LOSS OF MOTOR OVERHEATING DETECTION CIRCUIT. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 4K3 TO SHUT DOWN M-G SET IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3
			a. THERMISTOR COIL FAILS SHORT	RELAY MAY BE ENERGIZED CAUSING ALARM TO SOUND AND OVERHEATING INDICATOR LIGHT TO COME ON. DELAY OF OPERATION.	NO EFFECT.	3
			a. RELAY COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. ALARM WILL NOT SOUND AND OVERHEATING INDICATOR LIGHT WILL NOT LIGHT. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 4K3 TO SHUT DOWN M-G SET IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	ALARM WILL NOT SOUND AND OVERHEATING INDICATOR LIGHT WILL NOT LIGHT IF A MOTOR OVERHEAT OCCURS. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 4K3 TO SHUT DOWN M-G SET IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	OVERHEAT ALARM AND LIGHT WILL BE ON. DELAY OF OPERATION.	NO EFFECT.	3

Table 46 (Page 15 of 18). ELECTRICAL FMEA - TROLLEY DRIVE						
System 175-TON TROLLEY CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
4K2	RELAY	OVERHEATING TEMPERATURE SENSING RELAY IS ACTUATED WHEN A THERMISTOR IN THE WINDINGS OF TROLLEY MOTOR #2 REACHES A PREDETERMINED TEMPERATURE. THE CONTACTS CLOSE TO SOUND ALARM AND TURN ON OVERHEATING INDICATOR LIGHT.	a. THERMISTOR COIL FAILS OPEN	LOSS OF MOTOR OVERHEATING DETECTION CIRCUIT. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 4K4 TO SHUT DOWN M-G SET IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3
			a. THERMISTOR COIL FAILS SHORT	RELAY MAY BE ENERGIZED, CAUSING ALARM TO SOUND AND OVERHEATING INDICATOR LIGHT TO COME ON. DELAY OF OPERATION.	NO EFFECT.	3
			a. RELAY COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. ALARM WILL NOT SOUND AND OVERHEATING INDICATOR LIGHT WILL NOT LIGHT. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 4K4 TO SHUT DOWN M-G SET IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	ALARM WILL NOT SOUND AND OVERHEATING INDICATOR LIGHT WILL NOT LIGHT IF A MOTOR OVERHEAT OCCURS. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 4K4 TO SHUT DOWN M-G SET IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	OVERHEAT ALARM AND LIGHT WILL BE ON. DELAY OF OPERATION.	NO EFFECT.	3

Table 46 (Page 16 of 18). ELECTRICAL FMEA - TROLLEY DRIVE						
System 175-TON TROLLEY CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
4K3	RELAY	OVERHEATING TEMPERATURE SENSING RELAY IS ACTUATED WHEN A THERMISTOR IN THE WINDINGS OF TROLLEY DRIVE MOTOR #1 REACHES A PREDETERMINED TEMPERATURE. THE CONTACTS OPEN TO SHUT DOWN THE M-G SET.	a. THERMISTOR COIL FAILS OPEN	LOSS OF MOTOR OVERHEATING DETECTION CIRCUIT. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 4K1 TO SOUND ALARM AND LIGHT OVERHEATING INDICATOR LIGHT IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3
			a. THERMISTOR COIL FAILS SHORT	RELAY MAY BE ENERGIZED, CAUSING M-G SET TO SHUT DOWN. DELAY OF OPERATION.	NO EFFECT.	3
			a. RELAY COIL FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 4K1 TO SOUND ALARM AND LIGHT OVERHEATING INDICATOR LIGHT IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	M-G SET WILL NOT SHUT DOWN. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 4K1 TO SOUND ALARM AND LIGHT OVERHEATING INDICATOR LIGHT IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	M-G SET WILL NOT START. DELAY OF OPERATION.	NO EFFECT.	3

Table 46 (Page 17 of 18). ELECTRICAL FMEA - TROLLEY DRIVE						
System 175-TON TROLLEY CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
4K4	RELAY	OVERHEATING TEMPERATURE SENSING RELAY IS ACTUATED WHEN A THERMISTOR IN THE WINDINGS OF TROLLEY DRIVE MOTOR #2 REACHES A PREDETERMINED TEMPERATURE. THE CONTACTS OPEN TO SHUT DOWN THE M-G SET.	a. THERMISTOR COIL FAILS OPEN	LOSS OF MOTOR OVERHEATING DETECTION CIRCUIT. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 4K2 TO SOUND ALARM AND LIGHT OVERHEATING INDICATOR LIGHT IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3
			a. THERMISTOR COIL FAILS SHORT	RELAY MAY BE ENERGIZED, CAUSING M-G SET TO SHUT DOWN. DELAY OF OPERATION.	NO EFFECT.	3
			a. RELAY COIL FAILS OPEN	CONTACTS WILL REMAIN IN DE-ENERGIZED POSITION. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 4K2 TO SOUND ALARM AND LIGHT OVERHEATING INDICATOR LIGHT IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	M-G SET WILL NOT SHUT DOWN. A SECOND THERMISTOR IN THE SAME WINDINGS WILL ACTUATE RELAY 4K2 TO SOUND ALARM AND LIGHT OVERHEATING INDICATOR LIGHT IN THE EVENT OF AN OVERHEAT CONDITION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	M-G SET WILL NOT START. DELAY OF OPERATION.	NO EFFECT.	3
4F2	FUSE	PROTECTS FAN MOTORS, M37 & M38, FROM CURRENT OVERLOAD.	a. PREMATURE ACTUATION	FAN MOTORS, M37 & M38, WILL STOP. LOSS OF AIRFLOW IN THE RELAY CABINET. NO EFFECT ON CRANE OPERATION.	NO EFFECT.	3
			a. FAILS TO ACTUATE	POSSIBLE DAMAGE TO THE FAN MOTORS, M37 & M38. MULTIPLE FAILURE REQUIRED.	NO EFFECT.	3

Table 46 (Page 18 of 18). ELECTRICAL FMEA - TROLLEY DRIVE						
System 175-TON TROLLEY CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
M37, M38	FAN MOTORS	PROVIDES COOLING FOR THE DRIVE CONTROL RELAY CABINET.	a. FAILS TO OPERATE	LOSS OF AIRFLOW IN THE RELAY CABINET. NO EFFECT ON CRANE OPERATION.	NO EFFECT.	3

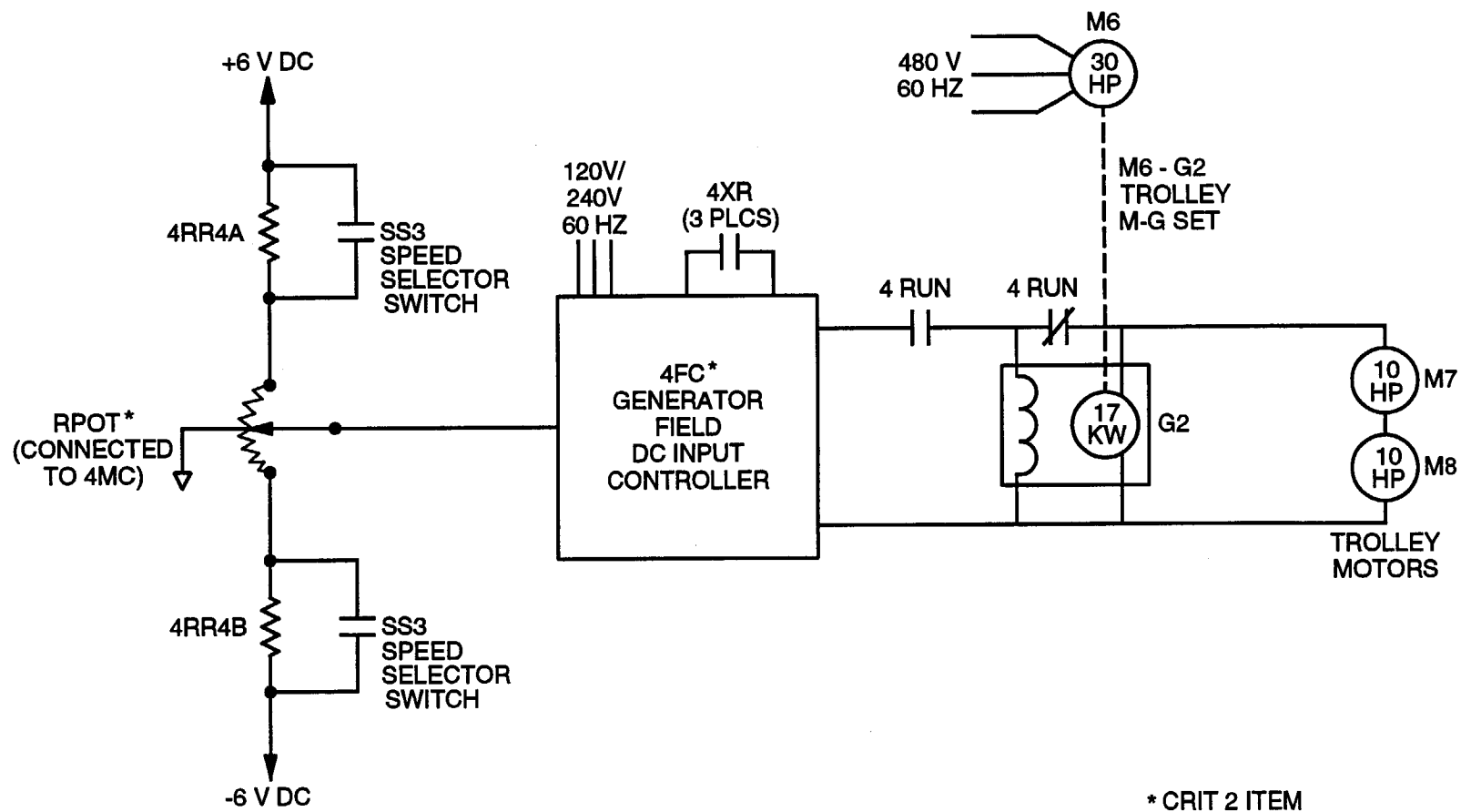


FIGURE 22. TROLLEY ELECTRICAL CONTROL SIMPLIFIED SCHEMATIC

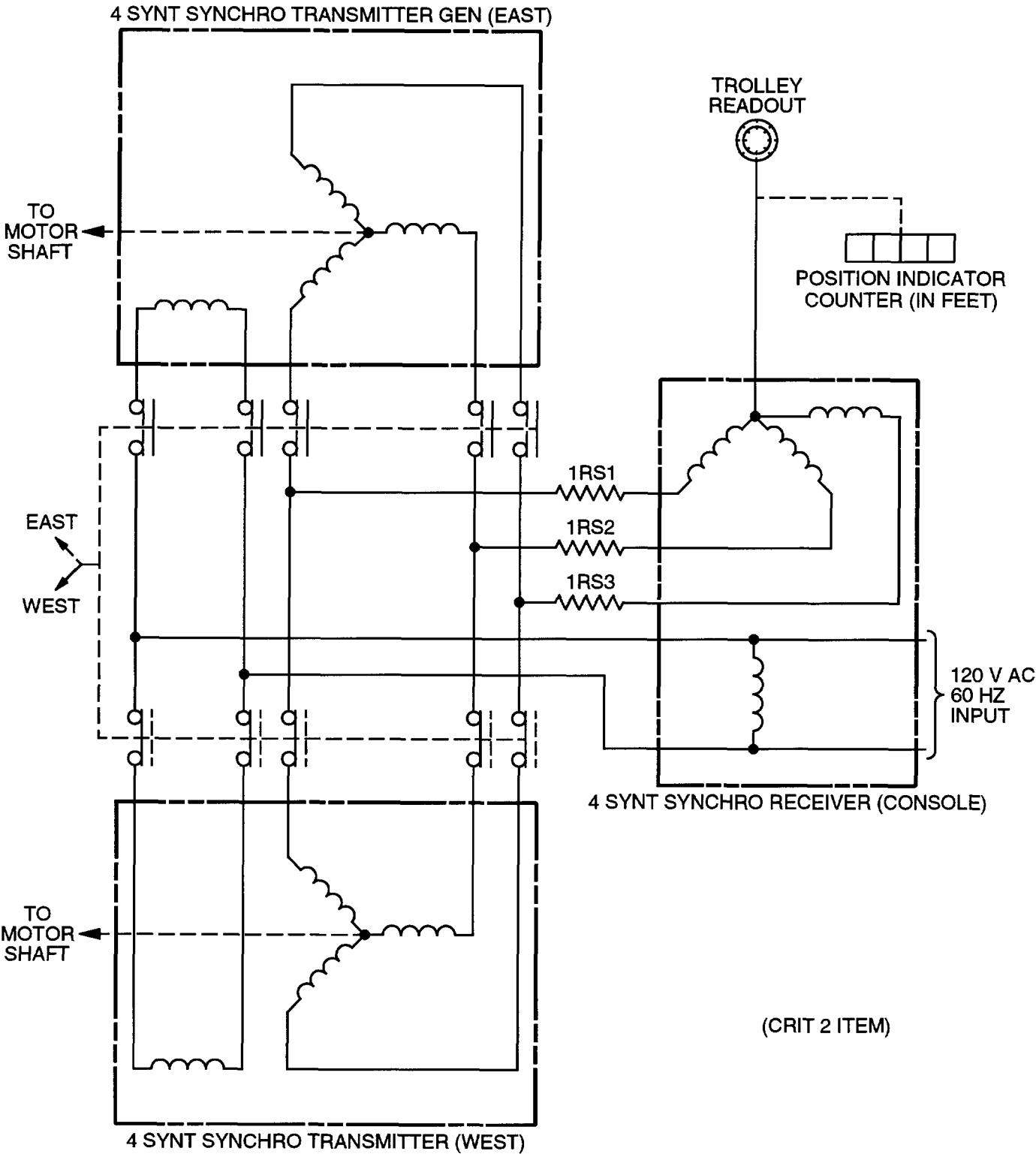


FIGURE 23. TROLLEY SYNCHRO TRANSMITTER AND RECEIVER (SELSYN)

Table 47 (Page 1 of 4). **ELECTRICAL FMEA - TROLLEY DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 22 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
RPOT	POTENTIO- METER	REFERENCE POTENTIOMETER CONNECTED TO THE MASTER CONTROL SWITCH (JOYSTICK), 4MC, TO REGU- LATE THE INPUT EXCITATION VOLTAGE TO THE GENER- ATOR FIELD DC INPUT CON- TROLLER, 4FC, AND THE RESULTING OUTPUT TO THE GENERATOR FIELD WINDING FOR TROLLEY MOTION CONTROL.	a. FAIL OPEN b. CORROSION, FATIGUE c. 09FY12-006.116 d. CURRENT INDICATION ON CONSOLE AMMETER e. BRING THE MASTER CONTROLLER TO NEUTRAL OR PRESS E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	IF THE FAILURE OCCURS ON THE RESISTIVE ELEMENT, IT WOULD RESULT IN A LOSS OF THE PARALLEL RESISTANCE BRANCH AND CREATE A LARGER INPUT INTO THE GENERATOR FIELD DC INPUT CONTROLLER WHICH WILL CAUSE AN INCREASING SPEED OF THE DC MOTORS CONTROLLING THE TROLLEY. OR IF THE FAILURE OCCURS ON THE WIPER ARM IT WOULD RESULT IN NO GENERATOR FIELD DC INPUT CON- TROLLER EXCITATION VOLTAGE. NO GENERATOR FIELD WINDING VOLTAGE. NO OUTPUT FROM GENERATOR. THE TROLLEY WILL NOT MOVE. DELAY OF OPERATIONS.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
4RR4A, 4RR4B	RESISTOR	PROVIDES A VOLTAGE DIVIDER FOR THE +/- 6VDC POWER SOURCE TO RPOT, FOR INPUT TO THE GENER- ATOR FIELD DC INPUT CON- TROLLER, 4FC, TO ALLOW FOR TROLLEY OPERATION IN THE FINE SPEED MODE.	a. FAILS OPEN	NO GENERATOR FIELD DC INPUT CON- TROLLER EXCITATION VOLTAGE IN THE FINE SPEED MODE OF OPERA- TION. NO GENERATOR FIELD WINDING VOLTAGE. NO OUTPUT FROM GENER- ATOR. UNABLE TO OPERATE THE TROLLEY IN THE FINE SPEED MODE. DELAY OF OPERATIONS.	NO EFFECT.	3
40LA	RELAY, OVERLOAD (INSTANTA- NEOUS)	SHUTS DOWN THE TROLLEY DRIVE M-G SET IF THE DRIVE MOTORS EXPERIENCE AN OVERLOAD. (NOTE GROUND RULE e).	a. N.C. CONTACT FAILS CLOSED a. N.C. CONTACT FAILS OPEN	M-G SET WILL NOT SHUT DOWN IF AN OVERLOAD CONDITION OCCURS. POS- SIBLE DAMAGE TO THE DC DRIVE MOTORS. MULTIPLE FAILURE REQUIRED. M-G SET WILL NOT RUN. DELAY OF OPERATION.	NO EFFECT.	3 3

Table 47 (Page 2 of 4). **ELECTRICAL FMEA - TROLLEY DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 22 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
4AM	AMMETER	PROVIDES INDICATION AT THE CONSOLE OF THE CURRENT TO THE TROLLEY DRIVE MOTORS.	a. FAILS OPEN	LOSS OF INDICATION TO OPERATOR OF MOTOR CURRENT. DELAY OF OPERATION.	NO EFFECT	3
4VR	RELAY, VOLTAGE	MONITORS VOLTAGE IN THE TROLLEY MOTOR LOOP AND PROVIDES LATCHING TO KEEP RELAYS HCR RUN, LCR RUN, 4NCR AND 4SCR ENERGIZED AFTER MASTER CONTROL SWITCH IS RETURNED TO THE NEUTRAL POSITION. THIS PREVENTS THE BRAKES FROM SETTING WHILE VOLTAGE IN THE MOTOR LOOP IS ABOVE A PREDETERMINED LIMIT.	a. COIL FAILS OPEN	CONTACT REMAINS IN DE-ENERGIZED POSITION. BRAKES WILL SET IMMEDIATELY WHEN THE MASTER CONTROL SWITCH IS MOVED TO THE STOP POSITION. POSSIBLE DAMAGE TO THE BRAKES.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	BRAKES WILL SET IMMEDIATELY WHEN THE MASTER CONTROL SWITCH IS MOVED TO THE STOP POSITION. POSSIBLE DAMAGE TO THE BRAKES.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	BRAKES WILL NOT SET WHEN THE MASTER CONTROL LEVER IS RETURNED TO THE NEUTRAL POSITION WITH RPOT CENTERED THERE WILL BE NO INPUT TO THE DC MOTORS AND THE TROLLEY WILL STOP.	NO EFFECT.	3

Table 47 (Page 3 of 4). **ELECTRICAL FMEA - TROLLEY DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 22 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
4KR	RELAY	ENERGIZES WHEN THE M-G SET IS STARTED TO ENERGIZE RELAY 4SRX WHICH BYPASSES RESISTOR RESA TO STRENGTHEN THE DC MOTOR FIELDS. THIS ALSO SUPPLIES POWER TO THE CABINET FAN MOTORS M37 & M38.	a. COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. THE DC MOTOR FIELD WILL BE WEAKENED. THIS WILL REDUCE THE TORQUE CAPABILITY OF THE DC MOTORS WHICH WILL CAUSE THE TROLLEY TO STOP WHEN A LOAD IS ON THE HOOK. DELAY OF OPERATIONS. SEE GROUND RULE i. CABINET FAN MOTORS WILL NOT COME ON. IF OVERHEATING OCCURS, THERMAL OVERLOADS WILL SHUT DOWN THE M-G SET. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. CONTACT FAILS OPEN	THE DC MOTOR FIELD WILL BE WEAKENED. THIS WILL REDUCE THE TORQUE CAPABILITY OF THE DC MOTORS WHICH WILL CAUSE THE TROLLEY TO STOP WITH A LOAD ON THE HOOK. DELAY OF OPERATIONS. SEE GROUND RULE i.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	RELAY 4SRX WILL REMAIN ENERGIZED AND THE DC MOTOR FIELD WILL REMAIN AT FULL STRENGTH.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	FAN MOTORS WILL NOT COME ON. LOSS OF AIRFLOW IN THE RELAY CABINET. NO EFFECT ON CRANE OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	FAN MOTORS WILL REMAIN ON.	NO EFFECT.	3

Table 47 (Page 4 of 4). **ELECTRICAL FMEA - TROLLEY DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 Sheet No. 25/26/27 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 22 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
4RF9, 4RF10	FUSE, 10A	PROVIDES PROTECTION AGAINST AN OVERCURRENT CONDITION FOR 4KR RELAY COIL.	a. PREMATURE ACTUATION	RELAY 4KR WILL BE DEENERGIZED WHICH WILL DISABLE THE TROLLEY CONTROLS. THE BRAKES WILL SET. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. FAILS TO ACTUATE	4KR RELAY COIL MAY BE EXPOSED TO HIGHER THAN EXPECTED CURRENTS. POSSIBLE DAMAGE TO THE RELAY COIL. MULTIPLE FAILURE REQUIRED.	NO EFFECT.	3

Table 48 (Page 1 of 3). ELECTRICAL FMEA - TROLLEY DRIVE						
System 175-TON TROLLEY CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
4CCB2	CIRCUIT BREAKER, 15AT	PROVIDES OVERLOAD PRO- TECTION FOR CIRCUIT PRO- VIDING POWER TO THE TROLLEY DRIVE MOTOR FIELD WINDINGS AND BRAKE SOLENOIDS.	a. PREMATURE TRIP	LOSS OF POWER TO THE TROLLEY MOTOR FIELD WINDINGS AND BRAKE SOLENOIDS. FIELD LOSS RELAYS (4FLA & 4FLB) WILL BE DEENERGIZED AND SHUT THE M-G SET DOWN. THE BRAKE SOLENOIDS WILL BE DEENER- GIZED AND SET THE BRAKES. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAILS TO TRIP	UPSTREAM BREAKER 12CB MAY TRIP CAUSING BRAKES TO SET. POSSIBLE DAMAGE TO THE MOTOR FIELD WINDINGS AND BRAKE SOLENOIDS. DELAY OF OPERATION.	NO EFFECT.	3
4SRX	RELAY	PROVIDES PATH FOR FULL POWER TO THE DC MOTOR FIELD WINDINGS BY BYPASSING RESISTOR RESA.	a. COILS FAILS OPEN	CONTACT REMAINS IN DE-ENERGIZED POSITION. THE DC MOTOR FIELD WILL BE WEAKENED. THIS WILL REDUCE THE TORQUE CAPABILITY OF THE DC MOTORS WHICH WILL CAUSE THE TROLLEY TO STOP WHEN A LOAD IS ON THE HOOK. DELAY OF OPER- ATIONS. SEE GROUND RULE I.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	THE DC MOTOR FIELD WILL BE WEAK- ENED. THIS WILL REDUCE THE TORQUE CAPABILITY OF THE DC MOTORS WHICH WILL CAUSE THE TROLLEY TO STOP WHEN A LOAD IS ON THE HOOK. DELAY OF OPER- ATIONS. SEE GROUND RULE I.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	THE DC MOTOR FIELD WILL REMAIN AT FULL STRENGTH.	NO EFFECT.	3

Table 48 (Page 2 of 3). ELECTRICAL FMEA - TROLLEY DRIVE						
System 175-TON TROLLEY CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 Sheet No. 26 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
4FLA, 4FLB	RELAY	PROVIDES PROTECTION IF POWER TO THE DC MOTOR FIELD WINDINGS IS LOST. N.O. CONTACT WILL OPEN TO SHUT DOWN THE M-G SET.	a. COIL FAILS OPEN a. N.O. CONTACT FAILS OPEN a. N.O. CONTACT FAILS CLOSED	CONTACT WILL REMAIN IN DE-ENERGIZED POSITION. M-G SET WILL NOT RUN. DELAY OF OPERATION. M-G SET WILL NOT RUN. DELAY OF OPERATION. IF POWER IS LOST IN THE MOTOR FIELD WINDING CIRCUIT, THE CONTACTS FOR THE OTHER FIELD LOSS RELAY WILL OPEN TO SHUT DOWN THE M-G SET. IF ONE MOTOR FIELD WINDING OPENS, THE REMAINING OPERATIONAL MOTOR CAN MOVE TROLLEY.	NO EFFECT. NO EFFECT. NO EFFECT.	3 3 3
RESA	RESISTOR	PROVIDES VOLTAGE DIVIDING CAPABILITY TO REDUCE THE VOLTAGE ACROSS THE DC MOTOR FIELD WINDINGS PRIOR TO M-G SET START.	a. FAIL OPEN	NO POWER TO THE FIELD WINDINGS PRIOR TO M-G SET START. THE M-G SET CAN'T BE STARTED BECAUSE THE FIELD LOSS RELAYS WILL NOT BE ENERGIZED. DELAY OF OPERATION.	NO EFFECT.	3
RESB	RESISTOR	PROVIDES VOLTAGE DIVIDING CAPABILITY TO REDUCE THE VOLTAGE ACROSS THE DC MOTOR FIELD WINDINGS.	a. FAIL OPEN	NO POWER TO THE FIELD WINDINGS. THE M-G SET WILL BE SHUT DOWN BY THE FIELD LOSS RELAYS. DELAY OF OPERATION.	NO EFFECT.	3
RESC	RESISTOR	PROVIDES VOLTAGE DIVIDING CAPABILITY TO REDUCE THE VOLTAGE ACROSS THE BRAKE SOLENOIDS.	a. FAIL OPEN	NO POWER TO THE BRAKE SOLENOIDS. BRAKES WILL NOT RELEASE WHEN THE MASTER CONTROLLER IS MOVED OUT OF NEUTRAL, OR THE BRAKE SWITCH IS ENGAGED, CAUSING POSSIBLE DAMAGE TO THE BRAKES. DELAY OF OPERATION.	NO EFFECT.	3

Table 48 (Page 3 of 3). ELECTRICAL FMEA - TROLLEY DRIVE						
System 175-TON TROLLEY CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
1RES1	RESISTOR, THYRITE	MAINTAINS PREDETERMINED VOLTAGE CEILING ACROSS THE BRAKE SOLENOIDS. THIS WILL NOT CONDUCT UNTIL IT REACHES THE BREAKDOWN VOLTAGE AT WHICH TIME IT WILL CONDUCT AND KEEP THE BRAKE SOLENOIDS AT THE PROPER VOLTAGE.	a. FAIL OPEN	BRAKE SOLENOIDS MAY BE EXPOSED TO HIGHER VOLTAGES THAN EXPECTED. POSSIBLE DAMAGE TO THE SOLENOIDS.	NO EFFECT.	3
BR	BRAKE SOLENOID (1 OF 2)	WHEN THE COILS, CONTROLLED BY RELAY 4BR, ARE ENERGIZED, THE BRAKES WILL RELEASE.	a. COIL FAILS OPEN	BRAKES WILL NOT RELEASE WHEN THE MASTER CONTROLLER IS MOVED OUT OF NEUTRAL, OR THE BRAKE SWITCH IS ENGAGED, CAUSING POSSIBLE DAMAGE TO THE BRAKES. DELAY OF OPERATION.	NO EFFECT.	3

Table 49 (Page 1 of 10). **ELECTRICAL FMEA - TROLLEY DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 Sheet No. 12/25/27/28 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 22, 23 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
4KRX	RELAY	PROVIDES PROTECTION AGAINST THE LOSS OF POWER TO THE GENERATOR FIELD DC INPUT CONTROLLER. RELAYS 4KR1, 4KR2, & 4KR3 MONITOR THIS POWER AND ENERGIZE THIS RELAY. THIS ENABLES THE TROLLEY CONTROLS IF THE POWER IS PRESENT AND IT DISABLES THE CONTROLS IF THE POWER IS NOT PRESENT.	a. COIL FAILS OPEN a. N.O. CONTACT FAILS OPEN a. N.O. CONTACT FAILS CLOSED	CONTACT REMAINS IN DE-ENERGIZED POSITION. TROLLEY CONTROLS WILL REMAIN DISABLED. DELAY OF OPERATIONS. TROLLEY CONTROLS WILL REMAIN DISABLED. DELAY OF OPERATIONS. LOSS OF ABILITY TO DISABLE THE TROLLEY CONTROLS IF POWER IS LOST TO ONE OF THE THREE RELAYS. MULTIPLE FAILURE REQUIRED.	NO EFFECT. NO EFFECT. NO EFFECT.	3 3 3
4KR1	RELAY	MONITORS POWER SUPPLIED TO THE GENERATOR FIELD DC INPUT CONTROLLER DOWNSTREAM OF TRANSFORMER 4RT1. THE N.O. CONTACT IS ARRANGED IN SERIES WITH CONTACTS OF RELAYS 4KR2 & 4KR3 WHICH CLOSE TO ENERGIZE RELAY 4KRX.	a. COIL FAILS OPEN a. N.O. CONTACT FAILS OPEN	CONTACT REMAINS IN DE-ENERGIZED POSITION. RELAY 4KRX WILL REMAIN DEENERGIZED. TROLLEY CONTROLS WILL REMAIN DISABLED. DELAY OF OPERATIONS. RELAY 4KRX WILL REMAIN DEENERGIZED. TROLLEY CONTROLS WILL REMAIN DISABLED. DELAY OF OPERATIONS.	NO EFFECT. NO EFFECT.	3 3

Table 49 (Page 2 of 10). **ELECTRICAL FMEA - TROLLEY DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 22, 23 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
4KR2	RELAY	MONITORS POWER SUPPLIED TO THE GENERATOR FIELD DC INPUT CONTROLLER DOWN-STREAM OF TRANSFORMER 4RT1. THE N.O. CONTACT IS ARRANGED IN SERIES WITH CONTACTS OF RELAYS 4KR1 & 4KR3 WHICH CLOSE TO ENERGIZE-RELAY 4KRX.	a. N.O. CONTACT FAILS CLOSED a. COIL FAILS OPEN	LOSS OF ABILITY TO DISABLE THE TROLLEY CONTROLS IF POWER FROM TRANSFORMER 4RT1 IS LOST. MULTIPLE FAILURE REQUIRED. CONTACT REMAINS IN DE-ENERGIZED POSITION. RELAY 4KRX WILL REMAIN DEENERGIZED. TROLLEY CONTROLS WILL REMAIN DISABLED. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	RELAY 4KRX WILL REMAIN DEENERGIZED. TROLLEY CONTROLS WILL REMAIN DISABLED. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	LOSS OF ABILITY TO DISABLE THE TROLLEY CONTROLS IF POWER FROM TRANSFORMER 4RT1 IS LOST. MULTIPLE FAILURE REQUIRED.	NO EFFECT.	3
4KR3	RELAY	MONITORS POWER SUPPLIED TO THE GENERATOR FIELD DC INPUT CONTROLLER DOWN-STREAM OF TRANSFORMER 4RT2. THE N.O. CONTACT IS ARRANGED IN SERIES WITH CONTACTS OF RELAYS 4KR1 & 4KR2 WHICH CLOSE TO ENERGIZE RELAY 4KRX.	a. COIL FAILS OPEN a. N.O. CONTACT FAILS OPEN	CONTACT REMAINS IN DE-ENERGIZED POSITION. RELAY 4KRX WILL REMAIN DEENERGIZED. TROLLEY CONTROLS WILL REMAIN DISABLED. DELAY OF OPERATIONS. RELAY 4KRX WILL REMAIN DEENERGIZED. TROLLEY CONTROLS WILL REMAIN DISABLED. DELAY OF OPERATIONS.	NO EFFECT.	3

Table 49 (Page 3 of 10). **ELECTRICAL FMEA - TROLLEY DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 22, 23 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
4RF1, 4RF2	FUSE, 2.5A	PROVIDES PROTECTION AGAINST AN OVERCURRENT CONDITION UPSTREAM OF TRANSFORMER 4RT1.	a. N.O. CONTACT FAILS CLOSED	LOSS OF ABILITY TO DISABLE THE TROLLEY CONTROLS IF POWER FROM TRANSFORMER 4RT2 IS LOST. MUL- TIPLE FAILURE REQUIRED.	NO EFFECT.	3
			a. PREMATURE ACTUATION	RELAYS 4KR1, & 4KR2 WILL BE DEEN- ERGIZED WHICH WILL DISABLE THE TROLLEY CONTROLS. THE BRAKES WILL SET. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. FAILS TO ACTUATE	TRANSFORMER 4RT1 AND GENERATOR FIELD DC INPUT CONTROLLER MAY BE EXPOSED TO HIGHER THAN EXPECTED CURRENTS. POSSIBLE DAMAGE TO THESE COMPONENTS. MULTIPLE FAILURE REQUIRED.	NO EFFECT.	3
4RF3	FUSE, 5A	PROVIDES PROTECTION AGAINST AN OVERCURRENT CONDITION DOWNSTREAM OF TRANSFORMER 4RT1.	a. PREMATURE ACTUATION	RELAY 4KR1 WILL BE DEENERGIZED WHICH WILL DISABLE THE TROLLEY CONTROLS. THE BRAKES WILL SET. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. FAILS TO ACTUATE	GENERATOR FIELD DC INPUT CON- TROLLER MAY BE EXPOSED TO HIGHER THAN EXPECTED CURRENTS. POSSIBLE DAMAGE TO THIS COMPO- NENT. MULTIPLE FAILURE REQUIRED.	NO EFFECT.	3
4RF4	FUSE, 5A	PROVIDES PROTECTION AGAINST AN OVERCURRENT CONDITION DOWNSTREAM OF TRANSFORMER 4RT1.	a. PREMATURE ACTUATION	RELAY 4KR2 WILL BE DEENERGIZED WHICH WILL DISABLE THE TROLLEY CONTROLS. THE BRAKES WILL SET. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. FAILS TO ACTUATE	GENERATOR FIELD DC INPUT CON- TROLLER MAY BE EXPOSED TO HIGHER THAN EXPECTED CURRENTS. POSSIBLE DAMAGE TO THIS COMPO- NENT. MULTIPLE FAILURE REQUIRED.	NO EFFECT.	3

Table 49 (Page 4 of 10). **ELECTRICAL FMEA - TROLLEY DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 Sheet No. 12/25/27/28 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 22, 23 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
4RF5, 4RF6	FUSE, .5A	PROVIDES PROTECTION AGAINST AN OVERCURRENT CONDITION UPSTREAM OF TRANSFORMER 4RT2.	a. PREMATURE ACTUATION	RELAY 4KR3 WILL BE DEENERGIZED WHICH WILL DISABLE THE TROLLEY CONTROLS. THE BRAKES WILL SET. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. FAILS TO ACTUATE	TRANSFORMER 4RT2 AND GENERATOR FIELD DC INPUT CONTROLLER MAY BE EXPOSED TO HIGHER THAN EXPECTED CURRENTS. POSSIBLE DAMAGE TO THESE COMPONENTS. MULTIPLE FAILURE REQUIRED.	NO EFFECT.	3
4RF7, 4RF8	FUSE, .5A	PROVIDES PROTECTION AGAINST AN OVERCURRENT CONDITION DOWNSTREAM OF TRANSFORMER 4RT2.	a. PREMATURE ACTUATION	RELAY 4KR3 WILL BE DEENERGIZED WHICH WILL DISABLE THE TROLLEY CONTROLS. THE BRAKES WILL SET. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. FAILS TO ACTUATE	GENERATOR FIELD DC INPUT CONTROLLER MAY BE EXPOSED TO HIGHER THAN EXPECTED CURRENTS. POSSIBLE DAMAGE TO THIS COMPONENT. MULTIPLE FAILURE REQUIRED.	NO EFFECT.	3
4RT1	ISOLATION TRANSFORMER	STEPS DOWN THE BUS VOLTAGE OF 480V TO THE DESIRED VOLTAGE OF 240V FOR USE IN THE GENERATOR FIELD DC INPUT CONTROLLER.	a. FAILS OPEN OR SHORT	LOSS OF POWER TO THE GENERATOR FIELD DC INPUT CONTROLLER. RELAYS 4KR1 & 4KR2 WILL BE DEENERGIZED TO DISABLE THE TROLLEY CONTROL CIRCUIT. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
4RT2	CONTROL TRANSFORMER	STEPS DOWN THE BUS VOLTAGE OF 480V TO THE DESIRED VOLTAGE OF 120V FOR USE IN THE GENERATOR FIELD DC INPUT CONTROLLER.	a. FAILS OPEN OR SHORT	LOSS OF POWER TO THE GENERATOR FIELD DC INPUT CONTROLLER. RELAY 4KR3 WILL BE DEENERGIZED TO DISABLE THE TROLLEY CONTROL CIRCUIT. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3

Table 49 (Page 5 of 10). ELECTRICAL FMEA - TROLLEY DRIVE						
System 175-TON BRIDGE CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 22, 23 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
4FC	GENERATOR FIELD DC INPUT CON- TROLLER	A SOLID STATE ASSEMBLY WHICH PROVIDES DC EXCITATION TO THE GENER- ATOR FIELD OF THE MOTOR-GENERATOR SET (M6-G2). THE EXCITATION IS PROPORTIONAL TO THE INPUT SUPPLIED FROM THE CONTROL POTENTIOMETER (RPOT) AND IS USED TO DRIVE THE DC MOTORS WHICH CONTROL THE TROLLEY.	a. NO OUTPUT	NO GENERATOR FIELD WINDING VOLTAGE. NO OUTPUT FROM THE GENERATOR. THE TROLLEY WILL NOT MOVE. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. HIGH OUTPUT (NOT INVERTED) b. BOARD COMPONENT SHORT, BOARD COMPO- NENT OPEN, LOSS OF VOLTAGE FEEDBACK FROM THE DC DRIVE MOTOR LOOP c. 09FY12-006.076 d. HIGH INDICATION OF CURRENT ON CONSOLE AMMETER, OR SPEED ON THE SELSYN e. BRING THE MASTER CONTROLLER TO NEUTRAL OR PRESS E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	INCREASE IN SPEED OF THE DC MOTORS CONTROLLING THE TROLLEY IN THE DIRECTION COMMANDED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2

Table 49 (Page 6 of 10). **ELECTRICAL FMEA - TROLLEY DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 22, 23 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
4XR	RELAY	ENABLES THE GENERATOR FIELD DC INPUT CONTROLLER SPEED REGULATOR, BI-DIRECTIONAL AMPLIFIER, AND FIRING CIRCUIT WHEN RELAY 4NCR OR 4SCR IS ENERGIZED, OR IF BRAKE SWITCH S1 IS ENGAGED.	a. HIGH OUTPUT (INVERTED) b. BOARD COMPONENT SHORT c. 09FY12-006.077 d. HIGH INDICATION OF CURRENT ON CONSOLE AMMETER, OR SPEED ON THE SELSYN e. BRING THE MASTER CONTROLLER TO NEUTRAL OR PRESS E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	INCREASE IN SPEED OF THE DC MOTORS CONTROLLING THE TROLLEY, IN THE OPPOSITE DIRECTION THAN COMMANDED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. NO GENERATOR FIELD DC INPUT CONTROLLER OUTPUT. NO GENERATOR FIELD WINDING VOLTAGE. NO OUTPUT FROM THE GENERATOR. THE TROLLEY WILL NOT MOVE. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN (1 OF 3)	NO GENERATOR FIELD DC INPUT CONTROLLER OUTPUT. NO GENERATOR FIELD WINDING VOLTAGE. NO OUTPUT FROM THE GENERATOR. THE TROLLEY WILL NOT MOVE. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED (1 OF 3)	THE GENERATOR FIELD DC INPUT CONTROLLER WILL REMAIN ENABLED. POSSIBLE DAMAGE TO THIS COMPONENT.	NO EFFECT.	3

System 175-TON BRIDGE CRANE, VAB
Subsystem TROLLEY DRIVE
Drawing No. 67-K-L-11348 Sheet No. 12/25/27/28
PMN K60-0528

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Date JULY 1993
Reference Figure Used 22, 23
Prepared By C. CRABB, LSOC 52-11

FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
4SYNT, 4SYNR	SYNCHRO TRANS- MITTER AND RECEIVER ASSEMBLY (SELSYN)	PROVIDES TROLLEY POSI- TION AND MOTION INDI- CATION TO THE OPERATOR IN THE CAB. THE OPERATOR USES THIS INDICATOR TO DETERMINE MOVEMENT DIS- TANCE WHEN REQUIRED TO MAKE SMALL INCREMENTAL MOVES FOR MATE OPER- ATIONS. THERE ARE TWO TRANSMITTERS THAT CAN SUPPLY THIS INDICATION TO THE RECEIVER. THE TRANS- MITTER TO BE USED HAS TO BE SELECTED BY A SWITCH EXTERNAL TO THE OPERA- TORS CAB.	a. ERRONEOUS OUTPUT (INDICATION) b. CORROSION, BINDING MECHANISM c. 09FY12-006.117 d. LOAD MOVEMENT NOT CORRESPONDING WITH CHANGE ON CONSOLE METER e. RETURN THE MASTER CONTROLLER TO NEUTRAL f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	LOSS OF ACCURATE POSITION INDI- CATION OR LOAD MOTION INDICATION COULD RESULT IN IMPROPER LOAD POSITIONING.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
4FOV	RELAY	PROTECTS AGAINST AN OVERVOLTAGE CONDITION IN THE DC MOTOR LOOP WHICH CAN RESULT IN A SPEED INCREASE OF THE TROLLEY. IT IS CONFIGURED TO SHUT DOWN THE M-G SET IF AN OVERVOLTAGE CONDITION (115% OF THE FULL FINE OUTPUT) IS DETECTED IN THE DC MOTOR LOOP WHILE IN THE FINE SPEED MODE.	a. COIL FAILS OPEN	N.O. CONTACT WILL REMAIN IN THE DE-ENERGIZED POSITION. TROLLEY M-G SET CANNOT BE STARTED. DELAY OF OPERATION.	NO EFFECT.	3
			a. COIL FAILS TO DEENER- GIZE	LOSS OF ABILITY TO SHUT DOWN THE M-G SET IF AN OVERVOLTAGE CONDI- TION EXISTS IN THE DC MOTOR LOOP. MULTIPLE FAILURE REQUIRED TO RESULT IN DAMAGE TO A VEHICLE SYSTEM.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	TROLLEY M-G SET CANNOT BE STARTED. DELAY OF OPERATION	NO EFFECT.	3

Table 49 (Page 8 of 10). **ELECTRICAL FMEA - TROLLEY DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 Sheet No. 12/25/27/28 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 22, 23 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
4FOV TRIP LIGHT	INDICATOR LIGHT	N.C. CONTACT CONTROLS POWER TO THE FOV TRIP LIGHT WHICH IS USED TO VERIFY PROPER OPERATION OF THIS RELAY DURING THE PRE-OPS CHECK. LIGHTS WHEN THE FOV CON- TACTS ARE IN THE DEENER- GIZED POSITION TO INDICATE THAT THE FOV RELAY IS DISABLED WHICH WILL PREVENT THE M-G SET FROM BEING STARTED. THIS IS EXTINGUISHED WHEN THE FOV RELAY IS ENABLED TO ALLOW FOR M-G SET START.	a. N.O. CONTACT FAILS CLOSED	LOSS OF ABILITY TO SHUT DOWN THE M-G SET IF AN OVERVOLTAGE CONDI- TION EXISTS IN THE DC MOTOR LOOP. MULTIPLE FAILURE REQUIRED TO RESULT IN DAMAGE TO A VEHICLE SYSTEM.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	FOV TRIP LIGHT WILL NOT COME ON. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	FOV TRIP LIGHT WILL REMAIN ON. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAIL OPEN	FAILS TO INDICATE THE PROPER OPERATION OF THE FOV RELAY. DELAY OF OPERATION.	NO EFFECT.	3
4FOV RECT	RECTIFIER, BRIDGE	MAINTAINS A POSITIVE VOLTAGE INPUT TO RELAY 4FOV REGARDLESS OF THE VOLTAGE POLARITY AND CURRENT DIRECTION IN THE DC MOTOR LOOP.	a. DIODE FAILS OPEN/SHORTED	NO INPUT FROM THE DC MOTOR LOOP TO THE OVERVOLTAGE RELAY. LOSS OF ABILITY TO SHUT DOWN THE M-G SET IF AN OVERVOLTAGE CONDITION EXISTS IN THE DC MOTOR LOOP. MULTIPLE FAILURE REQUIRED TO RESULT IN DAMAGE TO A VEHICLE SYSTEM.	NO EFFECT.	3

Table 49 (Page 9 of 10). **ELECTRICAL FMEA - TROLLEY DRIVE**

System 175-TON BRIDGE CRANE, VAB Subsystem TROLLEY DRIVE Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 22, 23 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
4TDTC	RELAY, TIME DELAY	BYPASSES THE OVER- VOLTAGE RELAY, 4FOV, WHEN ENERGIZED BY POSITIONING THE SPEED SELECTOR SWITCH, SS3 TO COARSE SPEED. THE TIME DELAY IS SET TO PROVIDE TIME FOR THE VOLTAGE IN THE DC MOTOR LOOP TO GO BELOW THE 115% FULL FINE VOLTAGE THRESHOLD WHEN THE SPEED SELECTOR SWITCH IS POSITIONED FROM COARSE TO FINE SPEED WHILE THE CRANE IS IN MOTION. THIS PREVENTS INADVERTENT SHUT DOWNS OF THE M-G SET.	a. COIL FAILS OPEN	N.O. CONTACT WILL REMAIN IN THE DE-ENERGIZED POSITION AND WON'T BYPASS THE OVERVOLTAGE RELAY. IF THE CRANE IS OPERATING IN THE COARSE SPEED MODE, THE OVER- VOLTAGE RELAY WILL SHUT DOWN THE M-G SET WHEN THE VOLTAGE IN THE DC MOTOR LOOP REACHES 115% OF THE FULL FINE OUTPUT.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	THE OVERVOLTAGE RELAY WON'T BE BYPASSED. IF THE CRANE IS OPER- ATING IN THE COARSE SPEED MODE, THE OVERVOLTAGE RELAY WILL SHUT DOWN THE M-G SET WHEN THE VOLTAGE IN THE DC MOTOR LOOP REACHES 115% OF THE FULL FINE OUTPUT.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	THE OVERVOLTAGE RELAY WILL BE BYPASSED WHEN THE SPEED SELECTOR SWITCH IS IN THE FINE SPEED POSITION. MULTIPLE FAILURE REQUIRED TO RESULT IN DAMAGE TO A VEHICLE SYSTEM.	NO EFFECT.	3

Table 50. ELECTRICAL FMEA - E-STOP CIRCUIT						
System 175-TON TROLLEY CRANE, VAB Subsystem E-STOP CIRCUIT Drawing No. 67-K-L-11348 Sheet No. 12/31 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
S4	SWITCH, EMERGENCY STOP	LOCATED IN THE OPERATOR'S CAB TO TRIP THE MAIN CIRCUIT BREAKER (MCB) AND SHUT DOWN THE CRANE IN THE EVENT OF A MALFUNCTION.	a. FAILS OPEN	UNABLE TO SHUT DOWN CRANE FROM THE OPERATOR'S CAB. GROUND OBSERVER CAN SHUT DOWN CRANE WITH E-STOP PENDANT SWITCH. MULTIPLE FAILURE REQUIRED TO RESULT IN LOSS OF LIFE AND/OR VEHICLE.	NO EFFECT.	3
			a. FAILS CLOSED	UNABLE TO OPERATE CRANE. DELAY OF OPERATION.	NO EFFECT.	3
S5	SWITCH, REMOTE EMERGENCY STOP	GROUND OBSERVER HAND HELD PENDANT USED TO TRIP THE MAIN CIRCUIT BREAKER (MCB) AND SHUT DOWN THE CRANE IN THE EVENT OF A MALFUNCTION.	a. FAILS OPEN	UNABLE TO SHUT DOWN CRANE FROM THE E-STOP PENDANT. OPERATOR CAN SHUT DOWN CRANE WITH E-STOP BUTTON IN CAB. MULTIPLE FAILURE REQUIRED TO RESULT IN LOSS OF LIFE AND/OR VEHICLE.	NO EFFECT.	3
			a. FAILS CLOSED	UNABLE TO OPERATE CRANE. DELAY OF OPERATION.		
PL34	INDICATION LAMP	INDICATES THAT EMERGENCY STOP PENDANT IS PROPERLY CONNECTED.	a. FAILS OPEN	UNABLE TO INDICATE IF PENDANT IS CONNECTED. DELAY OF OPERATION.	NO EFFECT.	3
R1	RESISTOR	MAINTAINS THE PROPER VOLTAGE ACROSS THE INDICATOR LAMP (PL34) ON THE E-STOP PENDANT.	a. FAILS OPEN	INDICATOR LAMP MAY NOT LIGHT. DELAY IN OPERATION.	NO EFFECT.	3

Table 51 (Page 2 of 8). **ELECTRICAL FMEA - SPEED SELECTION & INDICATION**

System 175-TON TROLLEY CRANE, VAB Subsystem SPEED INDICATION Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
	SWITCH CONTACT (1 OF 2)	PROVIDES CAPABILITY TO SELECT BETWEEN COARSE AND FINE MODE OF OPERA- TION. WHEN THE CONTACTS ARE CLOSED, THE VOLTAGE DIVIDING RESISTORS, 1RR4A OR 1RR4B, ARE BYPASSED AND THE MAIN HOIST IS OPERATED IN THE COARSE MODE. WHEN THE CONTACTS ARE OPEN, THE RESISTORS ARE IN THE CIRCUIT AND THE MAIN HOIST IS OPERATED IN THE FINE SPEED MODE. (NOTE GROUND RULE f).	a. CONTACT FAILS OPEN	UNABLE TO OPERATE IN COARSE SPEED. HOIST CAN OPERATED IN THE FINE MODE.	NO EFFECT.	3
			a. CONTACT FAILS CLOSED	UNABLE TO OPERATE IN FINE MODE. DELAY OF OPERATION.	NO EFFECT.	3
	SWITCH CONTACT	THE HIGH SPEED CONTACT, SS2-5, IN THE AUXILIARY HOIST ENABLES THE HIGH SPEED RELAYS TO BE ENER- GIZED WHEN THE MASTER CONTROLLER, 2MC, IS DIS- PLACED FROM NEUTRAL. THIS MODE OF OPERATION IS ONLY USED WHEN THERE IS NO LOAD ON THE HOOK. (NOTE GROUND RULE f).	a. CONTACT FAILS OPEN	UNABLE TO OPERATE IN HIGH SPEED MODE. HOIST CAN BE OPERATED IN THE COARSE MODE.	NO EFFECT.	3
			a. CONTACT FAILS CLOSED	UNABLE TO OPERATE IN FINE OR COARSE SPEED. DELAY OF OPERA- TION.	NO EFFECT.	3

Table 51 (Page 3 of 8). ELECTRICAL FMEA - SPEED SELECTION & INDICATION						
System 175-TON TROLLEY CRANE, VAB Subsystem SPEED INDICATION Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
	SWITCH CONTACT (1 OF 2)	PROVIDES CAPABILITY TO SELECT BETWEEN COARSE AND FINE MODE OF OPERA- TION. WHEN THE CONTACTS ARE CLOSED, THE VOLTAGE DIVIDING RESISTORS, 2RR4A OR 2RR4B, ARE BYPASSED AND THE AUXILIARY HOIST IS OPERATED IN THE COARSE MODE. WHEN THE CONTACTS ARE OPEN, THE RESISTORS ARE IN THE CIRCUIT AND THE AUXILIARY HOIST IS OPER- ATED IN THE FINE SPEED MODE. (NOTE GROUND RULE f).	a. CONTACT FAILS OPEN	UNABLE TO OPERATE IN COARSE SPEED. HOIST CAN OPERATED IN THE FINE MODE.	NO EFFECT.	3
			a. CONTACT FAILS CLOSED	UNABLE TO OPERATE IN FINE MODE. DELAY OF OPERATION.	NO EFFECT.	3
	SWITCH CONTACT	CONTACT, SS2-1, CLOSSES WHEN HIGH SPEED TRAVEL IS SELECTED, FOR EITHER HOIST, TO LIGHT INDICATOR PL2 AND ENERGIZE THE TIME DELAY RELAYS (1TDHH & 2TDHH) TO BYPASS THE OVERVOLTAGE RELAYS (1FOV & 2FOV).	a. FAILS OPEN	INDICATOR LIGHT PL2 WILL NOT LIGHT AND THE TIME DELAY RELAYS WILL NOT BE ENERGIZED. 1TDHH & 2TDHH N.O. CONTACTS WILL REMAIN IN THE DE-ENERGIZED POSITION AND WON'T BYPASS THE OVERVOLTAGE RELAYS. IF THE CRANE IS OPERATING IN THE HIGH SPEED MODE, THE OVER- VOLTAGE RELAY WILL SHUT DOWN THE M-G SET WHEN THE VOLTAGE IN THE DC MOTOR LOOP REACHES 115% OF THE FULL FINE OUTPUT. DELAY OF OPERATION.	NO EFFECT.	3

Table 51 (Page 5 of 8). ELECTRICAL FMEA - SPEED SELECTION & INDICATION						
System 175-TON TROLLEY CRANE, VAB Subsystem SPEED INDICATION Drawing No. 67-K-L-11348 Sheet No. 12/13/15/17/19/24/27 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
PL2	INDICATOR LIGHT	PROVIDES INDICATION THAT THE HOIST IS IN THE HIGH SPEED MODE OF TRAVEL.	a. FAILS CLOSED	INDICATOR LIGHT PL4 WILL REMAIN ON WHEN HOIST SPEED IS SWITCHED FROM FINE SPEED. DELAY OF OPERA- TION.	NO EFFECT.	3
PL3	INDICATOR LIGHT	PROVIDES INDICATION THAT THE HOIST IS IN THE COARSE SPEED MODE OF TRAVEL.	a. FAILS OPEN	NO INDICATION THAT THE HOIST IS IN THE HIGH SPEED MODE. DELAY OF OPERATION.	NO EFFECT.	3
PL4	INDICATOR LIGHT	PROVIDES INDICATION THAT HOIST IS IN THE FINE SPEED MODE OF TRAVEL.	a. FAILS OPEN	NO INDICATION THAT THE HOIST IS IN THE COARSE SPEED MODE. DELAY OF OPERATION.	NO EFFECT.	3
SS3	TRAVEL SPEED SELECTOR SWITCH	PROVIDES CAPABILITY TO SELECT THE SPEED DESIRED TO OPERATE THE BRIDGE AND TROLLEY. THE OPERA- TION OF THE BRIDGE AND TROLLEY SPEED SELECTION IS IDENTICAL BUT SEPARATE. THE SAME SWITCH IS USED TO CONTROL BOTH, BUT THE CONTACTS ARE INDE- PENDENT. THERE ARE TWO SPEED RANGES AVAILABLE: COARSE AND FINE. THE SPEED IS SELECTED BY THE OPERATOR DEPENDANT ON THE OPERATION BEING PER- FORMED.				

Table 51 (Page 6 of 8). **ELECTRICAL FMEA - SPEED SELECTION & INDICATION**

System 175-TON TROLLEY CRANE, VAB Subsystem SPEED INDICATION Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
	SWITCH CONTACT (1 OF 2)	PROVIDES CAPABILITY TO SELECT BETWEEN COARSE AND FINE MODE OF OPERA- TION. WHEN THE CONTACTS ARE CLOSED, THE VOLTAGE DIVIDING RESISTORS, 3RR4A OR 3RR4B, ARE BYPASSED AND THE BRIDGE IS OPER- ATED IN THE COARSE MODE. WHEN THE CONTACTS ARE OPEN THE RESISTORS ARE IN THE CIRCUIT AND THE BRIDGE IS OPERATED IN THE FINE SPEED MODE. (NOTE GROUND RULE f).	a. CONTACT FAILS OPEN	UNABLE TO OPERATE IN COARSE SPEED. BRIDGE CAN BE OPERATED IN THE FINE MODE.	NO EFFECT.	3
			a. CONTACT FAILS CLOSED	UNABLE TO OPERATE IN THE FINE SPEED MODE. DELAY OF OPER- ATIONS.	NO EFFECT.	3
	SWITCH CONTACT (1 OF 2)	PROVIDES CAPABILITY TO SELECT BETWEEN COARSE AND FINE MODE OF OPERA- TION. WHEN THE CONTACTS ARE CLOSED, THE VOLTAGE DIVIDING RESISTORS, 4RR4A OR 4RR4B, ARE BYPASSED AND THE TROLLEY IS OPER- ATED IN THE COARSE MODE. WHEN THE CONTACTS ARE OPEN THE RESISTORS ARE IN THE CIRCUIT AND THE TROLLEY IS OPERATED IN THE FINE SPEED MODE. (NOTE GROUND RULE f).	a. CONTACT FAILS OPEN	UNABLE TO OPERATE IN COARSE SPEED. TROLLEY CAN OPERATED IN THE FINE MODE.	NO EFFECT.	3
			a. CONTACT FAILS CLOSED	UNABLE TO OPERATE IN FINE MODE. DELAY OF OPERATION.	NO EFFECT.	3

Table 51 (Page 7 of 8). **ELECTRICAL FMEA - SPEED SELECTION & INDICATION**

System 175-TON TROLLEY CRANE, VAB Subsystem SPEED INDICATION Drawing No. 67-K-L-11348 Sheet No. 12/13/15/17/19/24/27 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
PL5	SWITCH CONTACT	CONTACT, SS3-5, CLOSES WHEN COARSE SPEED TRAVEL IS SELECTED FOR THE BRIDGE AND TROLLEY TO LIGHT INDICATOR PL5 AND ENERGIZE THE TIME DELAY RELAYS (3TDBC & 4TDC) TO BYPASS THE OVERVOLTAGE RELAYS (3FOV & 4FOV).	a. FAILS OPEN	INDICATOR LIGHT PL5 WILL NOT LIGHT AND THE TIME DELAY RELAYS WILL NOT BE ENERGIZED. 3TDBC & 4TDC N.O. CONTACTS WILL REMAIN IN THE DE-ENERGIZED POSITION AND WON'T BYPASS THE OVERVOLTAGE RELAYS. IF THE CRANE IS OPERATING IN THE COARSE SPEED MODE, THE OVERVOLTAGE RELAY WILL SHUT DOWN THE M-G SET WHEN THE VOLTAGE IN THE DC MOTOR LOOP REACHES 115% OF THE FULL FINE OUTPUT. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAILS CLOSED	INDICATOR LIGHT PL5 WILL REMAIN ON AND THE TIME DELAY RELAYS WILL BE ENERGIZED. THE OVERVOLTAGE RELAY WILL BE BYPASSED WHEN THE SPEED SELECTOR SWITCH IS IN THE FINE SPEED POSITION. MULTIPLE FAILURE REQUIRED TO RESULT IN DAMAGE TO A VEHICLE SYSTEM.	NO EFFECT.	3
	SWITCH CONTACT	CONTACT, SS3-6, CLOSES WHEN FINE SPEED TRAVEL IS SELECTED FOR THE BRIDGE AND TROLLEY TO LIGHT INDICATOR PL6.	a. FAILS OPEN	INDICATOR LIGHT PL6 WILL NOT LIGHT. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAILS CLOSED	INDICATOR LIGHT PL6 WILL REMAIN ON WHEN THE TRAVEL SPEED IS SWITCHED FROM FINE SPEED. DELAY OF OPERATION.	NO EFFECT.	3
	INDICATOR LIGHT	PROVIDES INDICATION THAT BRIDGE AND TROLLEY ARE IN COARSE SPEED MODE OF TRAVEL.	a. FAILS OPEN	NO INDICATION THAT THE BRIDGE AND TROLLEY ARE IN COARSE SPEED MODE. DELAY OF OPERATION.	NO EFFECT.	3

Table 51 (Page 8 of 8). **ELECTRICAL FMEA - SPEED SELECTION & INDICATION**

System 175-TON TROLLEY CRANE, VAB Subsystem SPEED INDICATION Drawing No. 67-K-L-11348 Sheet No. 12/13/15/17/19/24/27 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
PL6	INDICATOR LIGHT	PROVIDES INDICATION THAT BRIDGE AND TROLLEY ARE IN FINE SPEED MODE OF TRAVEL.	a. FAILS OPEN	NO INDICATION THAT THE BRIDGE AND TROLLEY ARE IN THE FINE SPEED MODE. DELAY OF OPERATION.	NO EFFECT.	3

Table 52 (Page 1 of 8). **ELECTRICAL FMEA - HOOK SWIVEL**

System 175-TON TROLLEY CRANE, VAB Subsystem HOOK SWIVEL Drawing No. 67-K-L-11348 Sheet No. 11,14 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
5CB F0L1, F0L2, F0L3	MAIN HOOK SWIVEL CIRCUIT BREAKER, 15AT	PROVIDES OVERLOAD PRO- TECTION FOR MAIN HOOK SWIVEL CIRCUIT.	a. PREMATURE TRIP	LOSS OF POWER TO HOOK SWIVEL MECHANISM. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAILS TO TRIP	POSSIBLE DAMAGE TO HOIST CIRCU- ITRY. UPSTREAM CB (1CB) MAY TRIP RESULTING IN LOSS OF POWER TO MAIN HOIST M-G SET. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
	OVERLOAD (FAST)	PROVIDES OVERLOAD PRO- TECTION IN EACH OF THE THREE FAST SPEED LEGS OF THE HOOK SWIVEL MOTOR. THREE N.C. CONTACTS, ARRANGED IN SERIES, OPEN TO SHUT DOWN THE HOOK SWIVEL MOTOR.	a. PREMATURE ACTUATION	LOSS OF POWER TO THE HOOK SWIVEL MOTOR. DELAY OF OPERA- TION.	NO EFFECT.	3
			a. FAILS TO ACTUATE	POSSIBLE DAMAGE TO THE HOOK SWIVEL MOTOR. UPSTREAM CB (5CB) MAY TRIP, RESULTING IN LOSS OF POWER TO THE HOOK SWIVEL MOTOR. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED (1 OF 3)	BACKUP CONTACT IN SERIES WILL OPEN TO SHUT DOWN THE HOOK SWIVEL MOTOR.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN (1 OF 3)	HOOK SWIVEL MOTOR WILL NOT RUN. DELAY OF OPERATION.	NO EFFECT.	3

Table 52 (Page 2 of 8). **ELECTRICAL FMEA - HOOK SWIVEL**

System 175-TON TROLLEY CRANE, VAB Subsystem HOOK SWIVEL Drawing No. 67-K-L-11348 Sheet No. 11,14 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
SOL1, SOL2, SOL3	OVERLOAD (SLOW)	PROVIDES OVERLOAD PROTECTION IN EACH OF THE THREE SLOW SPEED LEGS OF THE HOOK SWIVEL MOTOR. THREE N.C. CONTACTS, ARRANGED IN SERIES, OPEN TO SHUT DOWN THE HOOK SWIVEL MOTOR.	a. PREMATURE ACTUATION	LOSS OF POWER TO THE HOOK SWIVEL MOTOR. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAILS TO ACTUATE	POSSIBLE DAMAGE TO THE HOOK SWIVEL MOTOR. UPSTREAM CB (5CB) MAY TRIP, RESULTING IN LOSS OF POWER TO THE HOOK SWIVEL MOTOR. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED (1 OF 3)	BACKUP CONTACT IN SERIES WILL OPEN TO SHUT DOWN THE HOOK SWIVEL MOTOR.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN (1 OF 3)	HOOK SWIVEL MOTOR WILL NOT RUN. DELAY OF OPERATION.	NO EFFECT.	3
5TX1	TRANSFORMER	STEPS DOWN THE BUS VOLTAGE OF 480V TO 120V FOR THE HOOK SWIVEL CONTROL CIRCUIT.	a. FAILS OPEN OR SHORT	UNABLE TO SWIVEL HOOK. DELAY OF OPERATION.	NO EFFECT.	3
5F1	FUSE	PROVIDES OVERLOAD PROTECTION FOR HOOK SWIVEL CONTROL CIRCUIT.	a. PREMATURE ACTUATION	UNABLE TO SWIVEL HOOK. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAILS TO ACTUATE	POSSIBLE DAMAGE TO THE HOOK SWIVEL CONTROL CIRCUITRY. BREAKER 5CB MAY TRIP CAUSING LOSS OF ABILITY TO SWIVEL HOOK.	NO EFFECT.	3
5MC	SWITCH, SWIVEL CONTROL	PROVIDES CONTROL FOR DIRECTION AND SPEED OF HOOK SWIVEL.	a. N.O. CONTACT SS4-2 FAILS OPEN	UNABLE TO ENERGIZE RELAY CW FOR CLOCKWISE HOOK SWIVEL. DELAY OF OPERATION.	NO EFFECT.	3

Table 52 (Page 3 of 8). **ELECTRICAL FMEA - HOOK SWIVEL**

System 175-TON TROLLEY CRANE, VAB Subsystem HOOK SWIVEL Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
			a. N.O. CONTACT SS4-2 FAILS CLOSED	UNABLE TO DE-ENERGIZE RELAY CW TO DISENGAGE CLOCKWISE HOOK SWIVEL. LOAD WILL CONTINUE TO SWIVEL. CIRCUIT BREAKER 5CB CAN BE OPENED TO STOP THE SWIVEL. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT SS4-1 FAILS OPEN	UNABLE TO ENGAGE RELAY CCW FOR COUNTERCLOCKWISE HOOK SWIVEL. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT SS4-1 FAILS CLOSED	UNABLE TO DE-ENERGIZE RELAY CCW TO DISENGAGE COUNTERCLOCKWISE HOOK SWIVEL. LOAD WILL CONTINUE TO SWIVEL. CIRCUIT BREAKER 5CB CAN BE OPENED TO STOP THE SWIVEL. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT SS4-3 FAILS OPEN	UNABLE TO ENERGIZE RELAY F TO ENGAGE FAST SPEED HOOK SWIVEL. SWIVEL CAN OPERATE IN SLOW SPEED.	NO EFFECT.	3
			a. N.O. CONTACT SS4-3 FAILS CLOSED	UNABLE TO DE-ENERGIZE RELAY F TO DISENGAGE FAST SPEED HOOK SWIVEL TO OPERATE IN SLOW SPEED. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT SS3-3 FAILS OPEN	UNABLE TO START HYDRAULIC PUMP TO UNLOCK HOOK SWIVEL CLUTCH.	NO EFFECT.	3
			a. N.O. CONTACT SS3-3 FAILS CLOSED	PRESSURE SWITCH LS1 WILL OPEN TO DE-ENERGIZE UNLOCK RELAY AND SHUT DOWN HYDRAULIC PUMP AFTER HOOK SWIVEL CLUTCH IS UNLOCKED.	NO EFFECT.	3
			a. N.O. CONTACT SS3-4 FAILS OPEN	UNABLE TO START HYDRAULIC PUMP TO LOCK HOOK SWIVEL MECHANISM. DELAY OF OPERATION.	NO EFFECT.	3

Table 52 (Page 4 of 8). **ELECTRICAL FMEA - HOOK SWIVEL**

System 175-TON TROLLEY CRANE, VAB Subsystem HOOK SWIVEL Drawing No. 67-K-L-11348 Sheet No. 11,14 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
CW	RELAY	PROVIDES AC CONNECTION TO RUN HOOK SWIVEL MOTOR CLOCKWISE.	a. N.O. CONTACT SS3-4 FAILS CLOSED	PRESSURE SWITCH LS2 WILL OPEN TO DE-ENERGIZE LOCK RELAY AND SHUT DOWN HYDRAULIC PUMP AFTER HOOK SWIVEL CLUTCH IS LOCKED.	NO EFFECT.	3
			a. COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. UNABLE TO SWIVEL HOOK IN CLOCKWISE DIRECTION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN (1 OF 3)	HOOK SWIVEL MOTOR WILL NOT RECEIVE FULL POWER. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED (1 OF 3)	SERIES ARRANGED CONTACT OF RELAY F OR S WILL SHUT DOWN THE HOOK SWIVEL MOTOR.	NO EFFECT.	3
		CONTACT OPENS TO DISABLE RELAY CCW.	a. N.C. CONTACTS FAIL CLOSED	RELAY CCW WILL NOT BE ISOLATED FROM SWITCH 5MC.	NO EFFECT.	3
			a. N.C. CONTACTS FAIL OPEN	UNABLE TO ENERGIZE RELAY CCW AND RUN MOTOR FOR COUNTER- CLOCKWISE HOOK SWIVEL.	NO EFFECT.	3
		CONTACT CLOSSES TO ENER- GIZE RELAY S.	a. N.O. CONTACTS FAIL CLOSED	RELAY S (SLOW) WILL BE DEENER- GIZED BY SERIES ARRANGED CONTACT OF RELAY F.	NO EFFECT.	3
			a. N.O. CONTACTS FAIL OPEN	RELAY S (SLOW) CANNOT BE ENER- GIZED. LOSS OF SLOW SPEED OPERA- TION. DELAY OF OPERATION.	NO EFFECT.	3
CCW	RELAY	PROVIDES AC CONNECTION TO RUN HOOK SWIVEL MOTOR COUNTERCLOCKWISE.	a. COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. UNABLE TO SWIVEL HOOK IN COUNTERCLOCKWISE DIRECTION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN (1 OF 3)	HOOK SWIVEL MOTOR WILL NOT RECEIVE FULL POWER. DELAY OF OPERATION.	NO EFFECT.	3

Table 52 (Page 5 of 8). **ELECTRICAL FMEA - HOOK SWIVEL**

System 175-TON TROLLEY CRANE, VAB Subsystem HOOK SWIVEL Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
F	RELAY (FAST SPEED)	CONTACT OPENS TO DISABLE RELAY CW.	a. N.O. CONTACT FAILS CLOSED (1 OF 3)	SERIES ARRANGED CONTACT OF RELAY F OR S WILL SHUT DOWN THE HOOK SWIVEL MOTOR.	NO EFFECT.	3
			a. N.C. CONTACTS FAIL CLOSED	RELAY CW WILL NOT BE ISOLATED FROM SWITCH 5MC.	NO EFFECT.	3
			a. N.C. CONTACTS FAIL OPEN	UNABLE TO ENERGIZE RELAY CW AND RUN MOTOR FOR CLOCKWISE HOOK SWIVEL.	NO EFFECT.	3
		CONTACT CLOSES TO ENER- GIZE RELAY S.	a. N.O. CONTACTS FAIL CLOSED	RELAY S (SLOW) WILL BE DEENER- GIZED BY SERIES ARRANGED CONTACT OF RELAY F.	NO EFFECT.	3
			a. N.O. CONTACTS FAIL OPEN	RELAY S (SLOW) CANNOT BE ENER- GIZED. LOSS OF SLOW SPEED OPERA- TION. DELAY OF OPERATION.	NO EFFECT.	3
		PROVIDES AC CONNECTION TO RUN HOOK SWIVEL MOTOR AT FAST SPEED.	a. COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. HOOK CAN SWIVEL AT SLOW SPEED.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN (1 OF 3)	HOOK SWIVEL MOTOR WILL NOT RECEIVE FULL POWER. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED (1 OF 3)	SERIES ARRANGED CONTACT OF RELAY CW OR CCW WILL SHUT DOWN THE HOOK SWIVEL MOTOR.	NO EFFECT.	3
		CONTACT OPENS TO DISABLE RELAY S (SLOW).	a. N.C. CONTACT FAILS CLOSED	MOTOR WILL GET POWER ON BOTH FAST AND SLOW CIRCUITS. POSSIBLE DAMAGE TO THE MOTOR.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	UNABLE TO OPERATE HOOK SWIVEL IN SLOW SPEED. DELAY OF OPERATION.	NO EFFECT.	3

Table 52 (Page 6 of 8). ELECTRICAL FMEA - HOOK SWIVEL						
System 175-TON TROLLEY CRANE, VAB Subsystem HOOK SWIVEL Drawing No. 67-K-L-11348 Sheet No. 11,14 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
S OT LOCK	RELAY (SLOW SPEED)	PROVIDES AC CONNECTIONS TO RUN HOOK SWIVEL MOTOR AT SLOW SPEED.	a. COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. UNABLE TO SWIVEL HOOK AT SLOW SPEED. DELAY OF OPERA- TION.	NO EFFECT.	3
	OVERTEM- PERATURE SENSOR	SHUTS DOWN THE HOOK SWIVEL MOTOR IF AN OVER- TEMPERATURE CONDITION EXISTS.	a. N.O. CONTACT FAILS OPEN (1 OF 3)	HOOK SWIVEL MOTOR WILL NOT RECEIVE FULL POWER. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED (1 OF 3)	SERIES ARRANGED CONTACT OF RELAY CW OR CCW WILL SHUT DOWN THE HOOK SWIVEL MOTOR.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	UNABLE TO OPERATE HOOK SWIVEL MOTOR. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	POSSIBLE DAMAGE TO THE HOOK SWIVEL MOTOR. MULTIPLE FAILURE REQUIRED. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS OPEN	UNABLE TO OPERATE HOOK SWIVEL MOTOR HYDRAULIC PUMP. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED	POSSIBLE DAMAGE TO THE HOOK SWIVEL MOTOR HYDRAULIC PUMP. MULTIPLE FAILURE REQUIRED. DELAY OF OPERATION.	NO EFFECT.	3
	RELAY	PROVIDES POWER TO START THE HYDRAULIC PUMP TO ENGAGE THE HOOK SWIVEL CLUTCH.	a. COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. HYDRAULIC PUMP WILL NOT START AND THE CLUTCH WON'T ENGAGE. DELAY OF OPERATION.	NO EFFECT.	3

Table 52 (Page 7 of 8). ELECTRICAL FMEA - HOOK SWIVEL						
System 175-TON TROLLEY CRANE, VAB Subsystem HOOK SWIVEL Drawing No. 67-K-L-11348 Sheet No. 11,14 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
UNLOCK	RELAY	PROVIDES POWER TO START THE HYDRAULIC PUMP TO DISENGAGE THE HOOK SWIVEL CLUTCH.	a. N.O. CONTACT FAILS OPEN (1 OF 3)	HYDRAULIC PUMP WILL NOT START AND THE CLUTCH WON'T ENGAGE. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED (1 OF 3)	SERIES ARRANGED CONTACTS WILL OPEN TO SHUT DOWN THE HYDRAULIC PUMP.	NO EFFECT.	3
			a. COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. HYDRAULIC PUMP WILL NOT START AND THE CLUTCH WILL REMAIN ENGAGED. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN (1 OF 3)	HYDRAULIC PUMP WILL NOT START AND THE CLUTCH WILL REMAIN ENGAGED. DELAY OF OPERATIONS.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED (1 OF 3)	SERIES ARRANGED CONTACTS WILL OPEN TO SHUT DOWN THE HYDRAULIC PUMP.	NO EFFECT.	3
PL12	INDICATOR LIGHT	INDICATES WHEN HYDRAULIC PUMP IS RUNNING.	a. FAILS OPEN	OPERATOR WOULD NOT HAVE INDICATION THAT HYDRAULIC PUMP IS RUNNING. DELAY OF OPERATION.	NO EFFECT.	3
LS1	PRESSURE SWITCH	OPENS TO DE-ENERGIZE RELAY UNLOCK TO SHUT DOWN HYDRAULIC PUMP WHEN CLUTCH IS DISENGAGED.	a. FAILS CLOSED	HYDRAULIC PUMP WILL CONTINUE TO RUN AFTER CLUTCH IS DISENGAGED. POSSIBLE DAMAGE TO THE PUMP.	NO EFFECT.	3
			a. FAILS OPEN	UNABLE TO OPERATE HYDRAULIC PUMP TO DISENGAGE CLUTCH.	NO EFFECT.	3
LS2	PRESSURE SWITCH	OPENS TO DE-ENERGIZE RELAY LOCK TO SHUT DOWN HYDRAULIC PUMP WHEN CLUTCH IS ENGAGED.	a. FAILS CLOSED	HYDRAULIC PUMP WILL CONTINUE TO RUN AFTER CLUTCH IS ENGAGED. POSSIBLE DAMAGE TO THE PUMP.	NO EFFECT.	3

Table 52 (Page 8 of 8). **ELECTRICAL FMEA - HOOK SWIVEL**

System 175-TON TROLLEY CRANE, VAB Subsystem HOOK SWIVEL Drawing No. 67-K-L-11348 Sheet No. 11,14 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
PL13	INDICATOR LIGHT	INDICATES WHEN CLUTCH IS UNLOCKED AND NOT ENGAGED.	a. FAILS OPEN	UNABLE TO OPERATE HYDRAULIC PUMP TO ENGAGE CLUTCH. DELAY IN OPERATION.	NO EFFECT.	3
PL14	INDICATOR LIGHT	INDICATES WHEN CLUTCH IS LOCKED AND ENGAGED.	a. FAILS OPEN	OPERATOR WOULD NOT HAVE INDI- CATION THAT CLUTCH IS UNLOCKED. DELAY OF OPERATION.	NO EFFECT.	3
LS3	SWITCH	CLOSES TO LIGHT PL13 WHEN CLUTCH IS UNLOCKED.	a. FAILS CLOSED	OPERATOR WOULD NOT HAVE INDI- CATION THAT CLUTCH IS LOCKED. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAILS OPEN	LIGHT WILL STAY ON WHEN CLUTCH IS LOCKED. DELAY OF OPERATION.	NO EFFECT.	3
LS4	SWITCH	CLOSES TO LIGHT PL14 WHEN CLUTCH IS LOCKED.	a. FAILS CLOSED	LIGHT WILL NOT COME ON WHEN CLUTCH IS UNLOCKED. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAILS OPEN	LIGHT WILL STAY ON WHEN CLUTCH IS UNLOCKED. DELAY OF OPERATION.	NO EFFECT.	3

Table 53. **ELECTRICAL FMEA - CABLE REEL**

System 175-TON TROLLEY CRANE, VAB Subsystem CABLE REEL Drawing No. 67-K-L-11348 Sheet No. 11,14 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
6CB	CABLE REEL MOTOR CIRCUIT BREAKER, 15AT	PROVIDES OVERLOAD PRO- TECTION FOR MAIN HOIST CABLE REEL TORQUE MOTOR.	a. PREMATURE TRIP a. FAILS TO TRIP	LOSS OF POWER TO CABLE REEL MOTOR. MAIN HOIST WILL STOP. BRAKES WILL SET. DELAY OF OPERA- TION. POSSIBLE DAMAGE TO THE TORQUE MOTOR AND CONTROL CIRCUITRY. MULTIPLE FAILURE REQUIRED TO RESULT IN DAMAGE TO A VEHICLE SYSTEM. UPSTREAM CB (MCB) MAY TRIP RESULTING IN LOSS OF POWER TO MAIN BUS. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT. NO EFFECT.	3 3
CROL1, CROL2, CROL3	OVERLOAD	PROVIDES OVERLOAD PRO- TECTION IN EACH OF THE THREE LEGS OF THE CABLE TORQUE MOTOR. THREE N.C. CONTACTS, ARRANGED IN SERIES, OPEN TO SHUT DOWN THE MAIN HOIST M-G SET.	a. PREMATURE ACTUATION a. FAILS TO ACTUATE a. N.C. CONTACT FAILS CLOSED (1 OF 3) a. N.C. CONTACT FAILS OPEN (1 OF 3)	MAIN HOIST M-G SET WILL STOP. BRAKES WILL SET. DELAY OF OPERA- TION. POSSIBLE DAMAGE TO THE TORQUE MOTOR. MULTIPLE FAILURE REQUIRED TO RESULT IN DAMAGE TO A VEHICLE SYSTEM. UPSTREAM CB (6CB) MAY TRIP RESULTING IN LOSS OF POWER TO CABLE REEL. MAIN HOIST BRAKES WILL SET. DELAY OF OPERATION. BACKUP CONTACT IN SERIES WILL OPEN TO SHUT DOWN THE MAIN HOIST M-G SET. MAIN HOIST M-G SET WILL NOT RUN. DELAY OF OPERATION.	NO EFFECT. NO EFFECT. NO EFFECT. NO EFFECT.	3 3 3 3

Table 54 (Page 1 of 2). **ELECTRICAL FMEA - CABLE REEL**

System 175-TON BRIDGE CRANE, VAB Subsystem CABLE REEL Drawing No. 67-K-L-11348 Sheet No. 13/14 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
6CT	TRANS- FORMER	STEPS DOWN THE BUS VOLTAGE OF 480V TO 120V FOR THE CONTROL POWER FOR THE CABLE REEL TORQUE MOTOR.	a. FAILS OPEN OR SHORT	LOSS OF POWER TO RELAYS 6CR1 AND 6CR. M-G SET AND CABLE REEL MOTOR WILL STOP. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
6F1	FUSE	PROVIDES CIRCUIT OVER- LOAD PROTECTION.	a. PREMATURE TRIP	LOSS OF POWER TO RELAYS 6CR1 AND 6CR. M-G SET AND CABLE REEL MOTOR WILL STOP. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAILS TO TRIP	POSSIBLE DAMAGE TO HOIST CIRCU- ITRY. UPSTREAM CB (6CB) MAY TRIP RESULTING IN LOSS OF POWER TO RELAYS 6CR AND 6CR1. M-G SET AND CABLE REEL MOTOR WILL STOP. BRAKES WILL SET. DELAY OF OPERA- TION.	NO EFFECT.	3
6CR1	RELAY	CONTACT CLOSURES TO ENABLE THE MAIN HOIST START RELAY 1SR TO ALLOW THE M-G SET TO START.	a. COIL FAILS OPEN	CONTACT REMAINS IN DE-ENERGIZED POSITION. MAIN HOIST M-G SET WILL NOT START. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN	MAIN HOIST M-G SET WILL NOT START. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	MAIN HOIST M-G SET WILL NOT SHUT DOWN IF THE CABLE REEL CONTROL CIRCUIT OPENS. TORQUE MOTOR WOULD BE SHUT DOWN WHEN RELAY 6CR DEENERGIZES. DELAY OF OPERA- TION.	NO EFFECT.	3

System 175-TON BRIDGE CRANE, VAB Subsystem CABLE REEL Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
6CR	RELAY	PROVIDES POWER TO THE CABLE REEL TORQUE MOTOR AND THE CABLE REEL BRAKE SOLENOIDS.	a. COIL FAILS OPEN	CONTACTS REMAIN IN DE-ENERGIZED POSITION. CABLE REEL MOTOR WILL NOT START AND CABLE REEL BRAKE WILL NOT BE RELEASED WHEN THE MAIN HOIST IS STARTED. THE CABLE WOULD PULL THROUGH BRAKE RESISTANCE WHILE HOOK IS LOW- ERING BUT WOULD NOT RETRACT WHILE HOOK IS RAISING. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS OPEN (1 OF 3)	REDUCED POWER TO THE CABLE REEL MOTOR AND BRAKE SOLENOID. IF THE BRAKES DON'T RELEASE THE CABLE WOULD PULL THROUGH BRAKE RESISTANCE WHILE HOOK IS LOW- ERING BUT WOULD NOT RETRACT WHILE HOOK IS RAISING. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED (1 OF 3)	THE TORQUE MOTOR AND BRAKE SOLENOID WOULD BE DEENERGIZED AS EXPECTED.	NO EFFECT.	3
5BR	BRAKE SOLENOID (1 OF 2)	WHEN THE COIL, CON- TROLLED BY RELAY 6CR IS ENERGIZED, CABLE REEL BRAKES WILL RELEASE.	a. COIL FAILS OPEN	CABLE REEL BRAKE WILL NOT BE RELEASED WHEN THE MAIN HOIST IS STARTED. THE CABLE WOULD PULL THROUGH BRAKE RESISTANCE WHILE HOOK IS LOWERING BUT WOULD NOT RETRACT WHILE HOOK IS RAISING. DELAY OF OPERATION.	NO EFFECT.	3

Table 55 (Page 1 of 2). **ELECTRICAL FMEA - PHASE REVERSAL PROTECTION**

System 175-TON BRIDGE CRANE, VAB Subsystem PHASE REVERSAL PROTECTION Drawing No. 67-K-L-11348 Sheet No. 11/12/29 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
9CB	PHASE REVERSAL CIRCUIT BREAKER, 15AT	PROVIDES OVERLOAD PROTECTION FOR CRANE CONTROL CIRCUITRY.	a. PREMATURE TRIP	LOSS OF POWER TO EMERGENCY STOP CIRCUIT, SYNCHRO RECEIVERS (SELSYN) AND PHASE REVERSAL RELAY. DELAY OF OPERATION.	NO EFFECT.	3
			a. FAILS TO TRIP	POSSIBLE DAMAGE TO THE CRANE CONTROL CIRCUITRY. UPSTREAM CB (MCB) MAY TRIP RESULTING IN LOSS OF POWER TO MAIN BUS. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3
9CT1	CONTROL TRANSFORMER	STEPS DOWN THE BUS VOLTAGE OF 480V TO THE DESIRED CONTROL VOLTAGE OF 120V FOR THE EMERGENCY STOP CIRCUIT, SYNCHRO RECEIVERS (SELSYN) AND PHASE REVERSAL RELAY.	a. FAILS OPEN OR SHORT	LOSS OF POWER. THE PHASE REVERSAL RELAY WILL BE UNBALANCED AND TRIP THE MAIN BREAKERS FOR THE MAIN HOIST, AUX. HOIST, TROLLEY AND BRIDGE. DELAY OF OPERATION.	NO EFFECT.	3
9CT2	CONTROL TRANSFORMER	STEPS DOWN THE BUS VOLTAGE OF 480V TO THE DESIRED CONTROL VOLTAGE OF 120V FOR THE EMERGENCY STOP CIRCUIT, SYNCHRO RECEIVERS (SELSYN) AND PHASE REVERSAL RELAY.	a. FAILS OPEN OR SHORT	LOSS OF POWER. THE PHASE REVERSAL RELAY WILL BE UNBALANCED AND TRIP THE MAIN BREAKERS FOR THE MAIN HOIST, AUX. HOIST, TROLLEY AND BRIDGE. DELAY OF OPERATION.	NO EFFECT.	3
PRR	PHASE REVERSAL RELAY	MONITORS THE INPUT VOLTAGE FROM THE MCC BUS TO DETECT A CHANGE IN ELECTRICAL PHASE ROTATION AND OPEN CIRCUIT BREAKERS 1CB, 2CB, 3CB, & 4CB TO SHUT DOWN THE CRANE.	a. COIL FAILS OPEN	CONTACT WOULD NOT CLOSE TO OPEN THE CIRCUIT BREAKERS AND STOP ALL M-G SETS IF A PROBLEM IS DETECTED. POSSIBLE DAMAGE TO THE CRANE CONTROL CIRCUITRY.	NO EFFECT.	3

Table 55 (Page 2 of 2). **ELECTRICAL FMEA - PHASE REVERSAL PROTECTION**

System 175-TON BRIDGE CRANE, VAB Subsystem PHASE REVERSAL PROTECTION Drawing No. 67-K-L-11348 Sheet No. 11/12/29 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
			a. N.O. CONTACT FAILS OPEN	LOSS OF ABILITY TO OPEN THE CIRCUIT BREAKERS AND STOP ALL M-G SETS IF A PROBLEM IS DETECTED. POSSIBLE DAMAGE TO THE CRANE CONTROL CIRCUITRY.	NO EFFECT.	3
			a. N.O. CONTACT FAILS CLOSED	THE M-G SETS CAN'T BE STARTED. DELAY OF OPERATION.	NO EFFECT.	3

Table 56 (Page 1 of 6). **ELECTRICAL FMEA - BLOWER MOTORS**

System 175-TON BRIDGE CRANE, VAB Subsystem BLOWER MOTORS Drawing No. 67-K-L-11348 Sheet No. 11/13/17/23/25/28 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
10CB	BLOWER MOTOR CIRCUIT BREAKER, 15AT	PROVIDES OVERLOAD PRO- TECTION FOR THE MAIN HOIST, AUX HOIST, AND TROLLEY BLOWER MOTORS.	a. PREMATURE TRIP	LOSS OF POWER TO THE MAIN HOIST, AUX HOIST AND TROLLEY BLOWER MOTORS. POSSIBLE DAMAGE TO THE DRIVE MOTORS. IF THE DRIVE MOTORS OVERHEAT, INDICATOR LIGHTS ON THE CONSOLE AND THE ALARM WILL SIGNAL THE OPERATOR.	NO EFFECT.	3
			a. FAILS TO TRIP	POSSIBLE DAMAGE TO THE BLOWER MOTORS. UPSTREAM CB (MCB) MAY TRIP RESULTING IN LOSS OF POWER TO MAIN BUS. BRAKES WILL SET.	NO EFFECT.	3
11CB	BLOWER MOTOR CIRCUIT BREAKER, 15AT	PROVIDES OVERLOAD PRO- TECTION FOR THE BRIDGE BLOWER MOTORS.	a. PREMATURE TRIP	LOSS OF POWER TO THE BRIDGE BLOWER MOTORS. POSSIBLE DAMAGE TO THE DRIVE MOTORS. IF THE DRIVE MOTORS OVERHEAT, INDI- CATOR LIGHTS ON THE CONSOLE AND THE ALARM WILL SIGNAL THE OPER- ATOR.	NO EFFECT.	3
			a. FAILS TO TRIP	POSSIBLE DAMAGE TO THE BLOWER MOTORS. UPSTREAM CB (MCB) MAY TRIP RESULTING IN LOSS OF POWER TO MAIN BUS. BRAKES WILL SET.	NO EFFECT.	3
1MB0L1, 1MB0L2	THERMAL OVERLOADS	PROVIDE OVERLOAD PRO- TECTION IN EACH OF THE THREE LEGS OF THE MAIN HOIST BLOWER MOTORS. THREE N.C. CONTACTS, ARRANGED IN SERIES, OPEN TO DEENERGIZE THE OVER- LOAD RELAYS, 1-OLR1 OR 1-OLR2, TO SHUT OFF THE BLOWER MOTORS.	a. PREMATURE TRIP	LOSS OF POWER TO THE BLOWER MOTORS. THE INDICATOR LIGHTS ON THE CONSOLE WILL THE SIGNAL OPERATOR.	NO EFFECT.	3

Table 56 (Page 2 of 6). ELECTRICAL FMEA - BLOWER MOTORS						
System 175-TON BRIDGE CRANE, VAB Subsystem BLOWER MOTORS Drawing No. 67-K-L-11348 Sheet No. 11/13/17/23/25/28 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
M17, M18	MAIN HOIST BLOWER MOTORS, 1.5 HP	COMBINATION MOTOR AND FAN ASSEMBLIES PROVIDE FORCED AIR VENTILATION TO THE MAIN HOIST DRIVE MOTORS.	a. FAILS TO TRIP	POSSIBLE DAMAGE TO THE BLOWER MOTORS. UPSTREAM CB (10CB) MAY TRIP RESULTING IN LOSS OF POWER TO MAIN HOIST, AUX HOIST AND TROLLEY BLOWER MOTORS. IF THE DRIVE MOTORS OVERHEAT, THE LIGHTS ON THE CONSOLE AND THE ALARM WILL THE SIGNAL OPERATOR. THE M-G SET WILL SHUT DOWN. DELAY OF OPERATION.		
			a. N.C. CONTACT FAILS OPEN (1 OF 3)	BLOWER MOTORS WILL NOT COME ON. POSSIBLE DAMAGE TO THE DRIVE MOTORS. IF THE DRIVE MOTORS OVERHEAT, INDICATOR LIGHTS ON THE CONSOLE AND THE ALARM WILL SIGNAL THE OPERATOR. THE M-G SET WILL SHUT DOWN. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED (1 OF 3)	REDUNDANT CONTACT ARRANGED IN SERIES WILL OPEN TO DEENERGIZE THE OVERLOAD RELAYS AND SHUT DOWN THE BLOWER MOTORS.	NO EFFECT.	3
			a. NO OUTPUT	POSSIBLE DAMAGE TO THE DRIVE MOTORS. IF THE DRIVE MOTORS OVERHEAT, THE LIGHTS ON THE CONSOLE AND THE ALARM WILL THE SIGNAL OPERATOR. THE M-G SET WILL SHUT DOWN. DELAY OF OPERATION.	NO EFFECT.	3

Table 56 (Page 3 of 6). ELECTRICAL FMEA - BLOWER MOTORS						
System 175-TON BRIDGE CRANE, VAB Subsystem BLOWER MOTORS Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
2MB0L1, 2MB0L2	THERMAL OVERLOADS	PROVIDE OVERLOAD PROTECTION IN EACH OF THE THREE LEGS OF THE AUX HOIST BLOWER MOTORS. THREE N.C. CONTACTS, ARRANGED IN SERIES, OPEN TO DEENERGIZE THE OVERLOAD RELAYS, 2-OLR1 OR 2-OLR2, TO SHUT OFF THE BLOWER MOTORS.	a. PREMATURE TRIP	LOSS OF POWER TO THE BLOWER MOTORS. THE INDICATOR LIGHTS ON THE CONSOLE WILL THE SIGNAL OPERATOR.	NO EFFECT.	3
			a. FAILS TO TRIP	POSSIBLE DAMAGE TO THE BLOWER MOTORS. UPSTREAM CB (10CB) MAY TRIP RESULTING IN LOSS OF POWER TO MAIN HOIST, AUX HOIST AND TROLLEY BLOWER MOTORS. IF THE DRIVE MOTORS OVERHEAT, THE LIGHTS ON THE CONSOLE AND THE ALARM WILL THE SIGNAL OPERATOR. THE M-G SET WILL SHUT DOWN. DELAY OF OPERATION.		
			a. N.C. CONTACT FAILS OPEN (1 OF 3)	BLOWER MOTORS WILL NOT COME ON. POSSIBLE DAMAGE TO THE DRIVE MOTORS. IF THE DRIVE MOTORS OVERHEAT, INDICATOR LIGHTS ON THE CONSOLE AND THE ALARM WILL SIGNAL THE OPERATOR. THE M-G SET WILL SHUT DOWN. DELAY OF OPERATION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED (1 OF 3)	REDUNDANT CONTACT ARRANGED IN SERIES WILL OPEN TO DEENERGIZE THE OVERLOAD RELAYS AND SHUT DOWN THE BLOWER MOTORS.	NO EFFECT.	3

Table 56 (Page 5 of 6). **ELECTRICAL FMEA - BLOWER MOTORS**

System 175-TON BRIDGE CRANE, VAB Subsystem BLOWER MOTORS Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
M21, M22	TROLLEY BLOWER MOTORS .25 HP	COMBINATION MOTOR AND FAN ASSEMBLIES PROVIDE FORCED AIR VENTILATION TO THE TROLLEY DRIVE MOTORS.	a. N.C. CONTACT FAILS CLOSED (1 OF 3) a. NO OUTPUT	REDUNDANT CONTACT ARRANGED IN SERIES WILL OPEN TO DEENERGIZE THE OVERLOAD RELAYS AND SHUT DOWN THE BLOWER MOTORS. POSSIBLE DAMAGE TO THE DRIVE MOTORS. IF THE DRIVE MOTORS OVERHEAT, THE LIGHTS ON THE CONSOLE AND THE ALARM WILL THE SIGNAL OPERATOR. THE M-G SET WILL SHUT DOWN. DELAY OF OPERA- TION.	NO EFFECT. NO EFFECT.	3 3
3MB0L1- 3MB0L12	THERMAL OVERLOADS	PROVIDE OVERLOAD PRO- TECTION IN EACH OF THE THREE LEGS OF THE BRIDGE BLOWER MOTORS. THREE N.C. CONTACTS, ARRANGED IN SERIES, OPEN TO DEENER- GIZE THE OVERLOAD RELAYS, 3OLR1, 3OLR2, 3OLR3, OR 3OLR4 TO SHUT OFF THE BLOWER MOTORS.	a. PREMATURE TRIP a. FAILS TO TRIP	LOSS OF POWER TO THE BLOWER MOTORS. THE INDICATOR LIGHTS ON THE CONSOLE WILL THE SIGNAL OPERATOR. POSSIBLE DAMAGE TO THE BLOWER MOTORS. UPSTREAM CB (11CB) MAY TRIP RESULTING IN LOSS OF POWER TO THE BRIDGE BLOWER MOTORS. IF THE DRIVE MOTORS OVERHEAT, THE LIGHTS ON THE CONSOLE AND THE ALARM WILL THE SIGNAL OPERATOR. THE M-G SET WILL SHUT DOWN. DELAY OF OPERATION.	NO EFFECT.	3

Table 56 (Page 6 of 6). **ELECTRICAL FMEA - BLOWER MOTORS**

System 175-TON BRIDGE CRANE, VAB Subsystem BLOWER MOTORS Drawing No. 67-K-L-11348 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
M23, M24, M25, M26	BRIDGE BLOWER MOTORS	COMBINATION MOTOR AND FAN ASSEMBLIES PROVIDE FORCED AIR VENTILATION TO THE BRIDGE DRIVE MOTORS.	a. N.C. CONTACT FAILS OPEN (1 OF 3)	BLOWER MOTORS WILL NOT COME ON. POSSIBLE DAMAGE TO THE DRIVE MOTORS. IF THE DRIVE MOTORS OVERHEAT, INDICATOR LIGHTS ON THE CONSOLE AND THE ALARM WILL SIGNAL THE OPERATOR. THE M-G SET WILL SHUT DOWN. DELAY OF OPERA- TION.	NO EFFECT.	3
			a. N.C. CONTACT FAILS CLOSED (1 OF 3)	REDUNDANT CONTACT ARRANGED IN SERIES WILL OPEN TO DEENERGIZE THE OVERLOAD RELAYS AND SHUT DOWN THE BLOWER MOTORS.	NO EFFECT.	3
			a. NO OUTPUT	POSSIBLE DAMAGE TO THE DRIVE MOTORS. IF THE DRIVE MOTORS OVERHEAT, THE LIGHTS ON THE CONSOLE AND THE ALARM WILL THE SIGNAL OPERATOR. THE M-G SET WILL SHUT DOWN. DELAY OF OPERA- TION.	NO EFFECT.	3

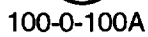


FIGURE 24. POWER SUPPLY FOR THE DC MOTOR FIELD WINDINGS AND THE BRAKE SOLENOIDS

Table 57 (Page 1 of 2). **ELECTRICAL FMEA - FIELD AND BRAKE CIRCUIT**

System 175-TON BRIDGE CRANE, VAB Subsystem FIELD AND BRAKE CIRCUIT Drawing No. 67-K-L-11348 Sheet No. 11/26 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 24 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
12CB	CIRCUIT BREAKER	PROVIDES OVERCURRENT PROTECTION FOR THE MOTOR FIELD WINDING AND BRAKE SOLENOID CIRCUITRY ON ALL FOUR DRIVE SYSTEMS.	a. CONTACT FAILS OPEN (1 OF 3) b. CORROSION, FATIGUE c. 09FY12-006.118 d. SELSYN POSITION INDI- CATOR e. PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	THE VOLTAGE SUPPLIED TO TRANS- FORMER 4TR3 WILL BE DIMINISHED. THE RESULTANT DC VOLTAGE TO THE MOTOR FIELD WINDINGS WILL BE REDUCED. THE FIELD WILL BE WEAK- ENED BY THE REDUCTION OF CURRENT THROUGH THE WINDINGS. THE MAIN OR AUX HOIST SPEED WILL INCREASE TO APPROXIMATELY TWO TIMES THE COMMANDED SPEED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2
			a. PREMATURE TRIP	LOSS OF POWER SUPPLY TO THE FIELD AND BRAKE CIRCUIT. THE FIELD LOSS RELAYS WILL BE DEENER- GIZED AND SHUT DOWN THE M-G SETS. LOSS OF POWER TO THE BRAKE SOLENOIDS. BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT	3
			a. FAILS TO TRIP	POSSIBLE DAMAGE TO CRANE CIRCU- ITRY. CIRCUIT BREAKER MCB, LOCATED UPSTREAM, MAY TRIP REMOVING POWER FROM THE CRANE. THE BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT	3
4TR3	TRANS- FORMER	THIS TRANSFORMER STEPS DOWN THE 3 PHASE 440 VAC, TO 240 VAC TO BE FED INTO A RECTIFIER WHICH ESTAB- LISHES THE 183 VDC FOR USE IN THE MOTOR FIELD WINDINGS AND THE BRAKE SOLENOIDS ON ALL FOUR DRIVE SYSTEMS.	a. WINDING FAILS OPEN OR SHORTED b. CORROSION, FATIGUE c. 09FY12-006.119 d. SELSYN POSITION INDI- CATOR e. PRESS THE E-STOP BUTTON f. SECONDS g. ESTIMATED 3 TO 10 SECONDS	THE VOLTAGE SUPPLIED TO THE RECTIFIER WILL BE DIMINISHED. THE RESULTANT DC VOLTAGE TO THE MOTOR FIELD WINDINGS AND THE BRAKE SOLENOIDS WILL BE REDUCED. THE FIELD WILL BE WEAKENED BY THE REDUCTION OF CURRENT THROUGH THE WINDINGS. THE MAIN OR AUX HOIST SPEED WILL INCREASE TO APPROXIMATELY TWO TIMES THE COMMANDED SPEED.	POSSIBLE DAMAGE TO A VEHICLE SYSTEM.	2

Table 57 (Page 2 of 2). ELECTRICAL FMEA - FIELD AND BRAKE CIRCUIT						
System 175-TON BRIDGE CRANE, VAB Subsystem FIELD AND BRAKE CIRCUIT Drawing No. 67-K-L-11348 Sheet No. 11/26 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 24 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
T3S1 - T3S3	THYRECTOR	PROVIDES PROTECTION AGAINST VOLTAGE SURGE.	a. DIODE FAIL OPEN/SHORTED	LOSS OF PROTECTION AGAINST A VOLTAGE SURGE. POSSIBLE DAMAGE TO THE MOTOR FIELD AND BRAKE SOLENOID CIRCUITRY.	NO EFFECT.	3
RT1-RT6	RECTIFIER	CONVERTS AC POWER TO DC POWER FOR USE IN THE MOTOR FIELD AND BRAKE SOLENOIDS.	a. DIODE FAIL OPEN	SMALL REDUCTION IN THE DC VOLTAGE SUPPLIED TO THE MOTOR FIELD AND BRAKE SOLENOIDS. THE REDUCTION IS NOT SIGNIFICANT ENOUGH TO CAUSE A SPEED INCREASE OF THE MAIN OR AUX HOISTS. MULTIPLE FAILURE REQUIRED TO RESULT IN DAMAGE TO A VEHICLE SYSTEM.	NO EFFECT.	3
			a. DIODE FAIL SHORT	POSSIBLE DAMAGE TO THE MOTOR FIELD AND BRAKE SOLENOID CIRCU- ITRY. CIRCUIT BREAKER 12CB MAY TRIP AND SHUT DOWN THE M-G SETS. BRAKES WILL SET.	NO EFFECT.	3
3AM	AMMETER	PROVIDES INDICATION OF CURRENT SUPPLIED TO THE MOTOR FIELD WINDINGS AND BRAKE SOLENOIDS ON ALL FOUR DRIVE SYSTEMS.	a. FAILS OPEN	LOSS OF POWER TO THE MOTOR FIELD WINDINGS AND BRAKE SOLENOIDS. THE M-G SETS WILL BE SHUT DOWN AND THE BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT.	3

Table 58 (Page 1 of 2). ELECTRICAL FMEA - OPERATORS RADIO POWER SUPPLY CIRCUIT						
System 175-TON BRIDGE CRANE, VAB Subsystem OPERATORS RADIO POWER SUPPLY CIRCUIT Drawing No. 67-K-L-11348 Sheet No. 29 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 25 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
CB8	CIRCUIT BREAKER	PROVIDES OVERCURRENT PROTECTION FOR THE OPER- ATORS CONSOLE RADIO AND THE CAB AIR CONDITIONING.	a. PREMATURE TRIP b. CORROSION, FATIGUE c. N/A d. VISUAL e. OBSERVER HITS THE E-STOP BUTTON f. 5 SECONDS g. ESTIMATED 2 TO 3 SECONDS	THE POWER SUPPLIED TO THE OPERA- TORS CAB RADIOS AND THE CAB AIR CONDITIONING WILL BE LOST. THE OPERATOR WILL HAVE NO COMMUNI- CATIONS WITH THE MOVE SUPER- VISOR ON THE FLOOR. IF AN ORDER TO STOP THE MOVE IS GIVEN AND NOT RECEIVED BY THE OPERATOR WHILE THE CRANE IS IN MOTION THE LOAD WILL CONTINUE TO MOVE UNTIL THE OBSERVER TAKES CORRECTING ACTION OR THE LOAD CONTACTS A SURROUNDING OBJECT.	NO EFFECT. CORRECTING ACTION WILL PREVENT THE LOAD FROM CONTACTING A SURROUNDING OBJECT.	3
T-1	TRANS- FORMER	THIS TRANSFORMER STEPS DOWN THE 3 PHASE 480 VAC, TO 120 VAC TO BE FED TO THE CIRCUIT LIGHTING PANEL.	a. FAILS TO TRIP	POSSIBLE DAMAGE TO THE OPERA- TORS RADIO AND THE CAB AIR CON- DITIONING CIRCUITRY. CIRCUIT BREAKER MCB, LOCATED UPSTREAM, MAY TRIP REMOVING POWER FROM THE CRANE. THE BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT	3
7CB	CIRCUIT BREAKER	PROVIDES OVERCURRENT PROTECTION FOR THE CIRCUIT LIGHTING PANEL.	a. WINDING FAILS OPEN OR SHORTED	THE POWER SUPPLIED TO THE CIRCUIT LIGHTING PANEL WILL BE DIMINISHED. THE LIGHTS IN THE CAB CONSOLE WILL BE DIMMED AND THE OPERATOR WILL STOP ALL CRANE OPERATIONS.	NO EFFECT.	3
			a. PREMATURE TRIP (1 OF 3)	THE VOLTAGE SUPPLIED TO TRANS- FORMER T-1 WILL BE DIMINISHED. THE LIGHTS IN THE CAB CONSOLE WILL BE DIMMED AND THE OPERATOR WILL STOP ALL CRANE OPERATIONS.	NO EFFECT.	3

Table 58 (Page 2 of 2). ELECTRICAL FMEA - OPERATORS RADIO POWER SUPPLY CIRCUIT						
System 175-TON BRIDGE CRANE, VAB Subsystem OPERATORS RADIO POWER SUPPLY CIRCUIT Drawing No. 67-K-L-11348 Sheet No. 29 PMN K60-0528			Program SPACE SHUTTLE		Station Set/Facility Code TA Date JULY 1993 Reference Figure Used 25 Prepared By C. CRABB, LSOC 52-11	
FIND NO. PART NO.	PART NAME	PART FUNCTION	a. FAILURE MODE b. CAUSE c. FMN d. DETECTION METHOD e. CORRECTING ACTION f. TIME TO EFFECT g. TIMEFRAME	FAILURE EFFECT ON SYSTEM PERFORMANCE	FAILURE EFFECT ON VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	CRIT CAT
			a. FAILS TO TRIP (1 OF 3)	POSSIBLE DAMAGE TO CIRCUIT LIGHTING PANEL. CIRCUIT BREAKER MCB, LOCATED UPSTREAM, MAY TRIP REMOVING POWER FROM THE CRANE. THE BRAKES WILL SET. DELAY OF OPERATION.	NO EFFECT	3

5.3 FLEXHOSE FMEA

There are no flexhoses associated with the critical functions assessed in section 4.0 for this system.

5.4 ORIFICE FMEA

There are no orifices associated with this system.

5.5 FILTER FMEA

There are no filters associated with the critical functions assessed in section 4.0 for this system.

6.0 CRITICAL ITEMS LIST

There were 61 Critical Items identified in this system. The Critical Items are summarized on the following Critical Hardware List (Worksheet 5312-012) and associated Critical Item Sheets (Worksheet 5312-013).

6.1 CRITICAL HARDWARE LIST

The Critical Items identified in this system are summarized on the following Critical Hardware List (Worksheet 5312-012).

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Hardware List

Project Element: 175-Ton Bridge Crane, VAB

Subsystem: Main Hoist

Table 59 (Page 1 of 3). CRITICAL HARDWARE LIST			
LRU PART NUMBER/ REFERENCE DESIGNATOR	LRU PART NAME	QTY (per subsystem)	LRU CRITICALITY
FMEA P/N	FMEA PART NAME/FMN	QTY (per LRU)	FM CRITICALITY
5008/79K16830-8 (M-16) 79K16830-8 (M-16)	CABLE REEL ASSEMBLY CABLE REEL ASSEMBLY/ FMN 09FY12-006.002 FMN 09FY12-006.003	1 1	2 2
C06X-TYPE D/M12-G4 M12-G4	MOTOR-GENERATOR SET MOTOR-GENERATOR SET/ FMN 09FY12-006.004	1 1	1 1
TYPE DV/M13, M14 M13, M14	DC MOTOR DC MOTOR/ FMN 09FY12-006.032	2 1	1 1
1C3012-K-620-D6/1MC 1MC	SWITCH, MASTER CONTROL SWITCH, MASTER CONTROL/ FMN 09FY12-006.005	1 1	2 2
CR120A06002AA/1HCR 1HCR	RELAY RELAY/ FMN 09FY12-006.006 FMN 09FY12-006.007	1 1	2 2
CR120A06002AA/1LCR 1LCR	RELAY RELAY/ FMN 09FY12-006.008 FMN 09FY12-006.009	1 1	2 2
CR120A06002AA/1HS 1HS	RELAY RELAY/ FMN 09FY12-006.098	1 1	2 2
9575H2068A/HCR RUN HCR RUN	RELAY RELAY/ FMN 09FY12-006.010 FMN 09FY12-006.011 FMN 09FY12-006.012	1 1	2 2
9575H2068A/LCR RUN LCR RUN	RELAY RELAY/ FMN 09FY12-006.013 FMN 09FY12-006.014 FMN 09FY12-006.015	1 1	2 2

Table 59 (Page 2 of 3). **CRITICAL HARDWARE LIST**

LRU PART NUMBER/ REFERENCE DESIGNATOR	LRU PART NAME	QTY (per subsystem)	LRU CRITICALITY
FMEA P/N	FMEA PART NAME/FMN	QTY (per LRU)	FM CRITICALITY
CR120AC4002AA/1XR 1XR	RELAY RELAY/ FMN 09FY12-006.016	1 1	2 2
15825K2CNN, 453D263GO2/1FW 1FW	RELAY RELAY/ FMN 09FY12-006.099 FMN 09FY12-006.100	1 1	2 2
805A-40/S2 S2	SWITCH, FOOT SWITCH, FOOT/ FMN 09FY12-006.023 FMN 09FY12-006.096 FMN 09FY12-006.097	1 1	2 2
M-011, 493A571GO1/1RUN 1RUN	RELAY RELAY/ FMN 09FY12-006.018 FMN 09FY12-006.019	1 1	2 2
RHS750/RPOT RPOT	POTENTIOMETER POTENTIOMETER/ FMN 09FY12-006.022	1 1	2 2
P 1.6KW-2/1RR4A, 1RR4B 1RR4A, 1RR4B	RESISTOR RESISTOR/ FMN 09FY12-006.065	2 1	2 2
RHS750/FPOT FPOT	POTENTIOMETER POTENTIOMETER/ FMN 09FY12-006.025	1 1	2 2
P 56KW-2/1RR7 1RR7	RESISTOR RESISTOR/ FMN 09FY12-006.066	1 1	2 2
CMC 3.5 4-L/M1 M1	RELAY RELAY/ FMN 09FY12-006.029	1 1	2 2
KHP 17411/K10 K10	RELAY RELAY/ FMN 09FY12-006.030 FMN 09FY12-006.031	1 1	2 2
1C2820 A1D0 AB2E/1VR 1VR	RELAY RELAY/ FMN 09FY12-006.033	1 1	2 2
CR105C0/1KR 1KR	RELAY RELAY/ FMN 09FY12-006.095	1 1	2 2
IC28001607F2/1SRX 1SRX	RELAY RELAY/ FMN 09FY12-006.101 FMN 09FY12-006.102	1 1	2 2

Table 59 (Page 3 of 3). **CRITICAL HARDWARE LIST**

LRU PART NUMBER/ REFERENCE DESIGNATOR	LRU PART NAME	QTY (per subsystem)	LRU CRITICALITY
FMEA P/N	FMEA PART NAME/FMN	QTY (per LRU)	FM CRITICALITY
URRK-VIII/1FC 1FC	GENERATOR FIELD DC INPUT CONTROLLER GENERATOR FIELD DC INPUT CONTROLLER/ FMN 09FY12-006.067 FMN 09FY12-006.072 FMN 09FY12-006.073	1 1	2 2
700-P400A1/1XR1 1XR1	RELAY RELAY/ FMN 09FY12-006.068 FMN 09FY12-006.069 FMN 09FY12-006.070 FMN 09FY12-006.071	1 1	2 2
2JDA66PA10A, 5PY-5GTY23/1SYNT/1SYNR1 1SYNT/1SYNR1	SYNCHRO TRANSMITTER AND RECEIVER ASSEMBLY SYNCHRO TRANSMITTER AND RECEIVER ASSEMBLY/ FMN 09FY12-006.103	1 1	2 2

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Hardware List

Project Element: 175-Ton Bridge Crane, VAB

Subsystem: Auxiliary Hoist

Table 60 (Page 1 of 3). Critical Hardware List			
LRU PART NUMBER/ REFERENCE DESIGNATOR	LRU PART NAME	QTY (per subsystem)	LRU CRITICALITY
FMEA P/N	FMEA PART NAME/FMN	QTY (per LRU)	FM CRITICALITY
TYPE E-TYPE D/M9-G3 M9-G3	MOTOR-GENERATOR SET MOTOR-GENERATOR SET/ FMN 09FY12-006.035	1 1	2 2
TYPE DV/M10, M11 M10, M11	DC MOTOR DC MOTOR/ FMN 09FY12-006.063	2 1	2 2
1C3012-K-620-D6/2MC 2MC	SWITCH, MASTER CONTROL SWITCH, MASTER CONTROL/ FMN 09FY12-006.036	1 1	2 2
CR120A06002AA/2HCR 2HCR	RELAY RELAY/ FMN 09FY12-006.037 FMN 09FY12-006.038	1 1	2 2
CR120A06002AA/2LCR 2LCR	RELAY RELAY/ FMN 09FY12-006.039 FMN 09FY12-006.040	1 1	2 2
CR120A06002AA/2HS 2HS	RELAY RELAY/ FMN 09FY12-006.105	1 1	2 2
9575H2068A/HCR RUN HCR RUN	RELAY RELAY/ FMN 09FY12-006.041 FMN 09FY12-006.042 FMN 09FY12-006.043	1 1	2 2
9575H2068A/LCR RUN LCR RUN	RELAY RELAY/ FMN 09FY12-006.044 FMN 09FY12-006.045 FMN 09FY12-006.046	1 1	2 2
CR120AC4002AA/2XR 2XR	RELAY RELAY/ FMN 09FY12-006.047	1 1	2 2

Table 60 (Page 2 of 3). **Critical Hardware List**

LRU PART NUMBER/ REFERENCE DESIGNATOR	LRU PART NAME	QTY (per subsystem)	LRU CRITICALITY
FMEA P/N	FMEA PART NAME/FMN	QTY (per LRU)	FM CRITICALITY
15825K2CNN, 453D263GO2/2FW 2FW	RELAY RELAY/ FMN 09FY12-006.106 FMN 09FY12-006.107	1 1	2 2
805A-40/S2 S2	SWITCH, FOOT SWITCH, FOOT/ FMN 09FY12-006.054 FMN 09FY12-006.108 FMN 09FY12-006.109	1 1	2 2
M-011, 493A571GO1/2RUN 2RUN	RELAY RELAY/ FMN 09FY12-006.049 FMN 09FY12-006.050	1 1	2 2
RHS750/RPOT RPOT	POTENTIOMETER POTENTIOMETER/ FMN 09FY12-006.053	1 1	2 2
P 1.6KW-2/2RR4A, 2RR4B 2RR4A, 2RR4B	RESISTOR RESISTOR/ FMN 09FY12-006.078	2 1	2 2
RHS750/FPOT FPOT	POTENTIOMETER POTENTIOMETER/ FMN 09FY12-006.056	1 1	2 2
P 56KW-2/2RR7 2RR7	RESISTOR RESISTOR/ FMN 09FY12-006.079	1 1	2 2
CMC 3.5 K-L/M2 M2	RELAY RELAY/ FMN 09FY12-006.060	1 1	2 2
KHP 17411/K9 K9	RELAY RELAY/ FMN 09FY12-006.061 FMN 09FY12-006.062	1 1	2 2
1C2820A100 AB2E/2VR 2VR	RELAY RELAY/ FMN 09FY12-006.064	1 1	2 2
CR105C0/2KR 2KR	RELAY RELAY/ FMN 09FY12-006.110	1 1	2 2
IC28001607F2/2SRX 2SRX	RELAY RELAY/ FMN 09FY12-006.111 FMN 09FY12-006.112	1 1	2 2
URRK-VIII/2FC 2FC	GENERATOR FIELD DC INPUT CONTROLLER GENERATOR FIELD DC INPUT CONTROLLER/ FMN 09FY12-006.084 FMN 09FY12-006.085 FMN 09FY12-006.086	1 1	2 2

Table 60 (Page 3 of 3). Critical Hardware List			
LRU PART NUMBER/ REFERENCE DESIGNATOR	LRU PART NAME	QTY (per subsystem)	LRU CRITICALITY
FMEA P/N	FMEA PART NAME/FMN	QTY (per LRU)	FM CRITICALITY
700-P400A1/2XR1 2XR1	RELAY RELAY/ FMN 09FY12-006.080 FMN 09FY12-006.081 FMN 09FY12-006.082 FMN 09FY12-006.083	1 1	2 2
2JDA66PA10A, 5PY-5GTY23/2SYNT/2SYNR2 2SYNT/2SYNR2	SYNCHRO TRANSMITTER AND RECEIVER ASSEMBLY SYNCHRO TRANSMITTER AND RECEIVER ASSEMBLY/ FMN 09FY12-006.113	1 1	2 2

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Hardware List

Project Element: 175-Ton Bridge Crane, VAB

Subsystem: Bridge

Table 61. CRITICAL HARDWARE LIST			
LRU PART NUMBER/ REFERENCE DESIGNATOR	LRU PART NAME	QTY (per subsystem)	LRU CRITICALITY
FMEA P/N	FMEA PART NAME/FMN	QTY (per LRU)	FM CRITICALITY
RHS750/RPOT RPOT	POTENTIOMETER POTENTIOMETER/ FMN 09FY12-006.115	1 1	2 2
URRK-VIII/3FC 3FC	GENERATOR FIELD DC INPUT CONTROLLER GENERATOR FIELD DC INPUT CONTROLLER/ FMN 09FY12-006.074 FMN 09FY12-006.075	1 1	2 2
2JDA66PA10A, 5PY-5GTY23/3SYNT/3SYNR 3SYNT/3SYNR	SYNCHRO TRANSMITTER AND RECEIVER ASSEMBLY SYNCHRO TRANSMITTER AND RECEIVER ASSEMBLY/ FMN 09FY12-006.114	1 1	2 2

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Hardware List

Project Element: 175-Ton Bridge Crane, VAB

Subsystem: Trolley

Table 62. CRITICAL HARDWARE LIST			
LRU PART NUMBER/ REFERENCE DESIGNATOR	LRU PART NAME	QTY (per subsystem)	LRU CRITICALITY
FMEA P/N	FMEA PART NAME/FMN	QTY (per LRU)	FM CRITICALITY
RHS750/RPOT RPOT	POTENTIOMETER POTENTIOMETER/ FMN 09FY12-006.116	1 1	2 2
URRK-VIII/4FC 4FC	GENERATOR FIELD DC INPUT CONTROLLER GENERATOR FIELD DC INPUT CONTROLLER/ FMN 09FY12-006.076 FMN 09FY12-006.077	1 1	2 2
2JDA66PA10A, 5PY-5GTY23/4SYNT/4SYNR 4SYNT/4SYNR	SYNCHRO TRANSMITTER AND RECEIVER ASSEMBLY SYNCHRO TRANSMITTER AND RECEIVER ASSEMBLY/ FMN 09FY12-006.117	1 1	2 2

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Hardware List

Project Element: 175-Ton Bridge Crane, VAB

Subsystem: Field and Brake Circuit

Table 63. CRITICAL HARDWARE LIST			
LRU PART NUMBER/ REFERENCE DESIGNATOR	LRU PART NAME	QTY (per subsystem)	LRU CRITICALITY
FMEA P/N	FMEA PART NAME/FMN	QTY (per LRU)	FM CRITICALITY
TEF 134040/12CB 12CB	CIRCUIT BREAKER CIRCUIT BREAKER/ FMN 09FY12-006.118	1 1	2 2
9T21A1004/4TR3 4TR3	TRANSFORMER TRANSFORMER/ FMN 09FY12-006.119	1 1	2 2

6.2 CRITICAL ITEMS LIST SHEETS

The rationale for accepting the risk of retaining the identified Critical Items is on the following Critical Items Sheets (Worksheet 5312-013).

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Cable Reel Assembly
Find Number: 79K16830-8 (M-16)
Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA		PMN/	K60-0528/
Part No:	NA	Name:	175-Ton Bridge Crane/VAB
Mfg/	Industrial Electric/	Drawing/	79K16830/
Part No:	Style #5008	Sheet No:	2

Function: Provides constant tension on hook swivel motor control cable that provides power from trolley to load block.

Critical Failure Mode/Failure Mode No:

- a. Fails to provide torque/09FY12-006.002
- b. Brake solenoid fails to engage/09FY12-006.003

Failure Cause:

- a. Open/shorted motor winding, chain drive, mechanical failure
- b. Binding mechanism

Failure Effect:

- a. Loss of torque to cable reel. Cable will unwind off cable reel when brakes are released possibly falling onto flight hardware. Possible damage to Vehicle System (TPS). Time to effect: seconds.
- b. Cable will unwind off cable reel when hoist stops, possibly falling onto flight hardware. Possible damage to Vehicle System (TPS). Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

- 1 HP torque motor
- 15 ft-lb brake
- This was designed for crane use and selected by the crane manufacturer for this application.

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.

Inspection:

- OMI Q6003, Maintenance Instructions requires following: annual inspection of the cable reel motor, brake and chain drive for wear and deterioration of parts; annual inspection of idler pulley for secureness of shaft; annual inspection of chain drive for tendency to bind; semiannual inspection of motor windings for signs of insulation deterioration from heating, chafing or aging, and for dirt or grease build-up; semiannual inspection of housing for cracks, missing or loose bolts, and obstructions that may interfere with rotation or ventilation.
- OMI Q3008 Pre-Operation Setup Instructions require inspection of main hoist cable reel assembly.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
There is no action which can be taken to mitigate the failure effect.
- Timeframe:
Since no correcting action is available, timeframe does not apply.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Motor - Generator Set, Main Hoist
Find Number: M12-G4
Criticality Category: 1

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA		PMN/	K60-0528/
Part No:	NA	Name:	175-Ton Bridge Crane/VAB
Mfg/	Motor: Imperial Electric/	Drawing/	67-K-L-11348/
Part No:	Type C06X Form C	Sheet No:	15
	Gen: Imperial Electric/		
	Type D Form C		

Function: Consists of a 300 HP motor coupled to a 170 KW DC generator to provide power to the armatures of the two 100 HP main hoist motors.

Critical Failure Mode/Failure Mode No: No output/09FY12-006.004

Failure Cause: Brush/commutator failure, open/shorted armature winding, structural failure (brush spring, brush yoke, brush rigging), open/shorted field winding, open/shorted cable or connector.

Failure Effect: Loss of main hoist motor armature current. Loss of main hoist motor torque while the command is being given to raise, lower, or float and the brakes are released. The load will drop without regenerative braking. The worst case would be the aft end of the orbiter being hoisted, lowered, or floated at approximately 80 feet above the VAB floor or the orbiter transporter, the failure occurring, and the effect being the aft end of the orbiter descending and striking the VAB floor or transporter at a speed of 210 ft/min resulting in a potential loss of life and/or vehicle. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

Motor

300 HP
480 VAC
1750 rpm
323 A

Generator

170 KW
480 VDC
1750 rpm
354 A

- This was designed for crane use and selected by the crane manufacturer for this application.

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.
- OMI Q3008, Pre-Operation Setup Instructions, requires current limit checks prior to all major lifts of flight hardware (verifies motor, generator, generator field DC input controller, float control loop and DC power loop components are operational).

Inspection:

- OMI Q3008, Pre-Operation Setup Instructions require visual and audible check of commutators on motor-generator set generator for proper operation and condition.
- OMI Q6003, Maintenance Instructions, requires semiannual inspection of brushes on motor-generator set generators for freedom of movement, wear, clearance, security and cleanliness.
- OMI Q6003, Maintenance Instructions, requires semiannual inspection of motor-generator set motors and motor-generator set generators for acceptable condition or damage.
- OMI Q6003, Maintenance Instructions, requires semiannual inspection of armature loop insulation resistance at each motor-generator set.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failures can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by pressing the E-Stop button.
 - 3) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 4) During all critical lifts, there is at least one remote Emergency Stop (E-Stop) operator observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: DC Motor, Main Hoist (2 total)

Find Number: M13, M14 (1 ea)

Criticality Category: 1

SAA No: 09FY12-006

System/Area: 175-Ton Bridge Crane/VAB

NASA

PMN/ K60-0528/

Part No: NA

Name: 175-Ton Bridge Crane/VAB

Mfg/ Imperial Electric/

Drawing/ 67-K-L-11348/

Part No: Type DV Form C,
Frame 69.7Z

Sheet No: 15

Function: Two 100 HP shunt wound DC motors with the armatures arranged in series to provide mechanical torque to raise, lower or float the load. The field windings, F1-F2 & F3-F4, provide a constant magnetic field to work against the varying magnetic field of the armature loop to produce torque.

Critical Failure Mode/Failure Mode No: Open armature winding/09FY12-006.032

Failure Cause: Brush/commutator failure, open/shorted armature winding, structural failure (brush spring, brush yoke, brush rigging), open/shorted cable or connector.

Failure Effect: Loss of armature DC current to both motors. Loss of main hoist motor torque while the command is given to raise, lower or float load and the brakes are released. The load will drop without regenerative braking. The worst case would be the aft end of the orbiter being hoisted, lowered, or floated at approximately 80 feet above the VAB floor or the orbiter transporter, the failure occurring, and the effect being the aft end of the orbiter descending and striking the VAB floor or transporter at a speed of 210 ft/min resulting in a potential loss of life and/or vehicle. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

- 100 HP
- 240 VDC (2 motors arranged in series with the 480 VDC generator)
- 340 A
- 500-1500 RPM
- Field and armature arranged in shunt configuration.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Relay, Main Hoist (2 total).

Find Number: HCR RUN, LCR RUN (1 ea)

Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA		PMN/	K60-0528/
Part No:	NA	Name:	175-Ton Bridge Crane/VAB
Mfg/	Cutler Hammer/	Drawing/	67-K-L-11348/
Part No:	9575H2068A Model:6-2-3	Sheet No:	13

Function: Controls relay 1RUN for energizing the generator field winding during hoisting, lowering or float operations.

Critical Failure Mode/Failure Mode No:

- a. Coil fails open/
 - 09FY12-006.010 (HCR RUN)
 - 09FY12-006.013 (LCR RUN)
- b. N.C. contact fails open/
 - 09FY12-006.011 (HCR RUN)
 - 09FY12-006.014 (LCR RUN)
- c. N.C. contact fails closed/
 - 09FY12-006.012 (HCR RUN)
 - 09FY12-006.015 (LCR RUN)

Failure Cause:

- a. Corrosion, fatigue
- b. Corrosion, binding mechanism.
- c. Welded contacts, binding mechanism.

Failure Effect: (For all three failures) Relay 1RUN N.O. contact will not close and generator field winding will not be energized. No output from the generator. No hoist motor torque while the command is being given to raise, lower or float the load and the brakes are released. The load will descend with regenerative braking at 0.25 ft/min (0.05 in/sec) max (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be attempting to lift or float an External Tank (ET) or the aft end of the

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Master Control Switch, Main Hoist
Find Number: 1MC
Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA		PMN/	K60-0528/
Part No:	NA	Name:	175-Ton Bridge Crane/VAB
Mfg/	General Electric/	Drawing/	67-K-L-11348/
Part No:	1C3012-K-620-D6	Sheet No:	13

Function: A "joystick" connected to mechanical contacts and reference potentiometer (RPOT), to provide the operator control of the main hoist for raising or lowering the load and releasing the brakes by energizing the hoist control or lower control relays in the normal mode of operation.

Critical Failure Mode/Failure Mode No: N.O. Contact fails closed/09FY12-006.005

Failure Cause: Welded contact, binding mechanism

Failure Effect: Brakes will not set when master control lever is returned to neutral position (no motor armature current). The load will descend with regenerative braking at 0.25 ft/min (0.05 in/sec) max (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be attempting to bring an External Tank (ET) or the aft end of the orbiter to a stop while hoisting or lowering, the failure occurring, and the effect being the ET or the aft end of the orbiter descending and striking the VAB floor or transporter, resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

- Double-break silver alloy contacts.
- Phenolic cams impregnated with graphite for self-lubrication to allow for millions of operations without significant wear.
- This switch was off-the-shelf hardware selected by the crane manufacturer for this application.

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.

- OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.

Inspection:

- OMI Q6003, Maintenance Instructions requires annual inspection of switch contacts and contact members for burning, pitting, proper alignment, and discoloration caused by over-heating.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via a brake set light or Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by pressing the E-Stop button.
 - 3) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 4) During all critical lifts, there is at least one Emergency Stop (E-Stop) operator remote from the operator's cab observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Relay, Main Hoist (2 total)

Find Number: 1HCR, 1LCR (1 ea)

Criticality Category: 2

SAA No: 09FY12-006

System/Area: 175-Ton Bridge Crane/VAB

NASA

PMN/

K60-0528/

Part No: NA

Name:

175-Ton Bridge Crane/VAB

Mfg/ General Electric/

Drawing/

67-K-L-11348/

Part No: CR120A06002AA

Sheet No:

13

Function: Provides power to the brake relays to release brakes during hoisting, lowering and float operations, and provides power to start the sequence that energizes the generator field winding.

- a. N.O. contact closes to energize HCR RUN (1HCR) or LCR RUN (1LCR) which energizes relay 1RUN.
- b. N.O. contact closes to energize relay 1XR, which releases the brakes, and relay 1XR1, which enables the generator field DC input controller.

Critical Failure Mode/Failure Mode No:

- a. N.O. contact fails open/
 - 09FY12-006.006 (1HCR)
 - 09FY12-006.008 (1LCR)
- b. N.O. contact fails closed/
 - 09FY12-006.007 (1HCR)
 - 09FY12-006.009 (1LCR)

Failure Cause:

- a. Corrosion, binding mechanism.
- b. Welded contacts, binding mechanism.

Failure Effect:

- a. Relay 1RUN N.O. contact will not close and generator field will not be energized. No output from the generator. No hoist motor torque while the command is being given to raise, lower or float the load and the brakes are released. The load will descend with regenerative braking at 0.25 ft/min (0.05 in/sec) max (based on maximum load capacity

of the hoist, in reality this would descend slower). The worst case would be attempting to lift or float an External Tank (ET) or the aft end of the orbiter from the stop position, releasing the brakes, the failure occurring, and the effect being the ET or the aft end of the orbiter descending and striking the VAB floor or transporter, resulting in possible damage to a vehicle system. Time to effect: seconds.

- b. Brake relays will remain energized and the brakes will not set when the hoist motors are commanded to stop (in normal operation). The load will descend with regenerative braking at 0.25 ft/min (0.05 in/sec) max (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be attempting to bring an ET or the aft end of the orbiter to a stop while lowering, the failure occurring, and the effect being the ET or the aft end of the orbiter continuing to lower, resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Contact Ratings</u>	<u>Actual</u>
300 volts	120 volts
10 amps	Testing required

- Contact Material: Silver Cadmium Oxide, Self-cleaning
- Mechanical life expectancy is 10 million operations.
- This relay was off-the-shelf hardware selected by the crane manufacturer for this application.

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.

Inspection:

- OMI Q6003, Maintenance Instructions, requires annual inspection of contacts and contact members for burning, pitting, proper alignment, and discoloration caused by overheating; visual check of closing coils for deteriorated insulation and evidence of overheating or burning.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via the brake set light or Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by returning the Master Control Switch to neutral or pressing the E-Stop button (releasing the brake switch in the float mode).
 - 3) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 4) During all critical lifts, there is at least one remote Emergency Stop (E-Stop) operator observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Relay, Main Hoist

Find Number: 1HS

Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA	NA	PMN/	K60-0528/
Part No:		Name:	175-Ton Bridge Crane/VAB
Mfg/	General Electric/	Drawing/	67-K-L-11348/
Part No:	CR120A06002AA	Sheet No:	13

Function: The relay energizes to open the normally closed (N.C.) contact which deenergizes relay 1FW to allow the hoist to operate in the high speed mode.

Critical Failure Mode/Failure Mode No: Contact Fails Open/09FY12-006.098

Failure Cause: Corrosion, binding mechanism

Failure Effect: The N.C. contact will open, deenergizing relay 1FW, which places resistors 1FWR and RES A in series with the DC motor field windings. The field will be weakened by the reduction of current through the windings. The hoist will be in the high speed mode configuration. The worst case scenario would be lowering an External Tank (ET) or the aft end of an orbiter in the coarse speed mode (maximum coarse speed is 10 ft/min), the failure occurring causing the hoist speed to increase to approximately three times the commanded speed, resulting in the ET or the aft end of the orbiter striking the VAB floor or transporter resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Contact Ratings</u>	<u>Actual</u>
300 volts	120 volts
10 amps	Testing required

- Contact Material: Silver Cadmium Oxide, Self-cleaning.
- This relay was off-the-shelf hardware selected by the crane manufacturer for this application.

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems to be operated briefly in all speeds to verify satisfactory operation before lifting operations.

Inspection:

- OMI Q6003, Maintenance Instructions, requires annual inspection of contacts and contact members for burning, pitting, proper alignment, and discoloration caused by overheating; visual check of closing coils for deteriorated insulation and evidence of overheating or burning.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by pressing the E-Stop button.
 - 3) Operationally, the crane must be operated in the fine or float speed mode if a critical load is within 10 feet of any structure.
 - 4) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 5) During all critical lifts, there is at least one remote Emergency Stop (E-Stop) operator observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Relay, Main Hoist (2 total).

Find Number: HCR RUN, LCR RUN (1 ea)

Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA		PMN/	K60-0528/
Part No:	NA	Name:	175-Ton Bridge Crane/VAB
Mfg/	Cutler Hammer/	Drawing/	67-K-L-11348/
Part No:	9575H2068A Model:6-2-3	Sheet No:	13

Function: Controls relay 1RUN for energizing the generator field winding during hoisting, lowering or float operations.

Critical Failure Mode/Failure Mode No:

- a. Coil fails open/
 - 09FY12-006.010 (HCR RUN)
 - 09FY12-006.013 (LCR RUN)
- b. N.C. contact fails open/
 - 09FY12-006.011 (HCR RUN)
 - 09FY12-006.014 (LCR RUN)
- c. N.C. contact fails closed/
 - 09FY12-006.012 (HCR RUN)
 - 09FY12-006.015 (LCR RUN)

Failure Cause:

- a. Corrosion, fatigue
- b. Corrosion, binding mechanism.
- c. Welded contacts, binding mechanism.

Failure Effect: (For all three failures) Relay 1RUN N.O. contact will not close and generator field winding will not be energized. No output from the generator. No hoist motor torque while the command is being given to raise, lower or float the load and the brakes are released. The load will descend with regenerative braking at 0.25 ft/min (0.05 in/sec) max (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be attempting to lift or float an External Tank (ET) or the aft end of the

orbiter from the stop position, releasing the brakes, the failure occurring, and the effect being the ET or the aft end of the orbiter descending and striking the VAB floor or transporter, resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Contact Ratings</u>	<u>Actual</u>
600 volts	120 volts
10 amps	Testing required

<u>Coil Ratings</u>	<u>Actual</u>
120 volts	120 volts

- Contacts - Weld resistant, dome shaped, self wiping, silver cadmium oxide, double break operation.
- Coils - Bobbin wound coils are varnish impregnated under vacuum to prevent corrosion due to moisture.
- Armature - Balanced armature to minimize bounce for maximum contact life.
- Shock and vibration resistant construction.
- This relay was off-the-shelf hardware selected by the crane manufacturer for this application.

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.

Inspection:

- OMI Q6003, Maintenance Instructions, requires annual inspection of relay contacts and contact members for burning, pitting, proper alignment, and discoloration caused by overheating; visual check of closing coils for deteriorated insulation and evidence of overheating or burning.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by returning the Master Control Switch to neutral or pressing the E-Stop button (releasing the brake switch in the float mode).
 - 3) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 4) During all critical lifts, there is at least one Emergency Stop (E-Stop) operator remote from the operator's cab observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Relay, Main Hoist

Find Number: 1XR

Criticality Category: 2

SAA No: 09FY12-006

System/Area: 175-Ton Bridge Crane/VAB

NASA

PMN/ K60-0528/

Part No: NA

Name: 175-Ton Bridge Crane/VAB

Mfg/ General Electric/

Drawing/ 67-K-L-11348/

Part No: CR120AC4002AA

Sheet No: 13

Function: N.O. contacts close to energize the brake relays, 1BR and 1BR1, when the main hoist controller is moved to release the brakes in normal operation.

Critical Failure Mode/Failure Mode No: N.O. contact fail closed/09FY12-006.016

Failure Cause: Welded contact, binding mechanism

Failure Effect: Brake relays will remain energized. Brakes will not set when main hoist motors are commanded, via the Master Control Switch to stop. The load will descend with regenerative braking at 0.25 ft/min (0.05 in/sec) max (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be attempting to bring an External Tank (ET) or the aft end of the orbiter to a stop while lowering, the failure occurring, and the effect being the ET or the aft end of the orbiter descending and striking the VAB floor or transporter, resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Contact Ratings</u>	<u>Actual</u>
300 volts	120 volts
10 amps	Testing required

- Contact Material: Silver Cadmium Oxide, Self-cleaning.
- This relay was off-the-shelf hardware selected by the crane manufacturer for this application.

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.

- OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.

Inspection:

- OMI Q6003, Maintenance Instructions, requires annual inspection of contacts and contact members for burning, pitting, proper alignment, and discoloration caused by overheating; visual check of closing coils for deteriorated insulation and evidence of overheating or burning.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via the brake set light or Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by pressing the E-Stop button.
 - 3) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 4) During all critical lifts, there is at least one Emergency Stop (E-Stop) operator remote from the operator's cab observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Relay, Main Hoist

Find Number: 1FW

Criticality Category: 2

SAA No: 09FY12-006

System/Area: 175-Ton Bridge Crane/VAB

NASA NA

PMN/ K60-0528/

Part No:

Name: 175-Ton Bridge Crane/VAB

Mfg/ Westinghouse/

Drawing/ 67-K-L-11348/

Part No: Cat. # 15825K2CNN,
Style # 453D263G02

Sheet No: 12, 13

Function: The relay energizes when power is applied to the crane, closing the three normally open (N.O.) contacts. The two series arranged contacts bypass resistor 1FWR to allow an increase in current to the DC motor field windings to strengthen the field. The third enables, but does not energize relay 1SRX.

The relay is deenergized while in the high speed mode, which opens the contacts, to place resistors 1FWR and RES A in series with the field windings to reduce the current and weaken the field.

Critical Failure Mode/Failure Mode No:

- a. Coil Fails Open/09FY12-006.099
- b. N.O. Contact Fails Open (1 of 3)/09FY12-006.100

Failure Cause:

- a. Corrosion, fatigue
- b. Corrosion, binding mechanism.

Failure Effect:

- a. The N.O. contacts will be opened placing resistors 1FWR and RES A in series with the DC motor field windings. The field will be weakened by the reduction of current through the windings. The hoist will be in the high speed mode configuration. The worst case scenario would be lowering an External Tank (ET) or the aft end of an orbiter in the coarse speed mode (maximum coarse speed is 10 ft/min), the failure occurring causing the hoist speed to increase to approximately three times the commanded speed, resulting in the ET or the aft end of the orbiter striking the VAB floor or transporter resulting in possible damage to a vehicle system. Time to effect: seconds.

- b. The N.O. contacts (1 of 3) will be opened placing resistor 1FWR or RES A in series with the DC motor field windings. The field will be weakened by the reduction of current through the windings. The hoist will descend at a higher rate of speed than expected (speed will be approximately double of the commanded input). The worst case scenario would be lowering an External Tank (ET) or the aft end of an orbiter in the coarse speed mode (maximum coarse speed is 10 ft/min), the failure occurring causing the hoist speed to increase to approximately two times the commanded speed, resulting in the ET or the aft end of the orbiter striking the VAB floor or transporter resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Contact Ratings</u>	<u>Actual</u>
600 volts	183 volts
50 amps	14 amps
<u>Coil Ratings</u>	<u>Actual</u>
550 volt-amps	Testing required

- Contact material: silver.
- This relay was off-the-shelf hardware selected by the crane manufacturer for this application.

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems to be operated briefly in all speeds to verify satisfactory operation before lifting operations.

Inspection:

- OMI Q6003, Maintenance Instructions, requires annual inspection of contacts and contact members for burning, pitting, proper alignment, and discoloration caused by overheating; visual check of closing coils for deteriorated insulation and evidence of overheating or burning.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by pressing the E-Stop button.
 - 3) Operationally, the crane must be operated in the fine or float speed mode if a critical load is within 10 feet of any structure.
 - 4) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 5) During all critical lifts, there is at least one remote Emergency Stop (E-Stop) operator observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Foot Switch, Main Hoist

Find Number: S2

Criticality Category: 2

SAA No: 09FY12-006

System/Area: 175-Ton Bridge Crane/VAB

NASA

PMN/ K60-0528/

Part No: NA

Name: 175-Ton Bridge Crane/VAB

Mfg/ Allen Bradley/

Drawing/ 67-K-L-11348/

Part No: 805A-40

Sheet No: 13, 15

Function:

- a. Switch contact located between RPOT and the Generator Field DC Input Controller, arranged to disable the RPOT input when operating in the float mode.
- b. Contact closes to energize relay 1HCR to operate the crane in the float mode.
- c. Contact opens to enable the operator to control the brakes with brake switch S1 for float mode operations.

Critical Failure Mode/Failure Mode No:

- a. N.O. contact fails open/09FY12-006.023
- b. N.O. contact fails closed/09FY12-006.096
- c. N.C. contact fails closed/09FY12-006.097

Failure Cause:

- a. Corrosion, mechanical failure.
- b. Corrosion, welded contact, mechanical failure.
- c. Corrosion, welded contact, mechanical failure.

Failure Effect:

- a. No RPOT Generator Field DC Input Controller excitation voltage and the resulting output to the generator field winding. No output from generator. No hoist motor torque while the command is being given, via the Master Control Switch to raise or lower and the brakes are released. The load will descend with regenerative braking at 0.25 ft/min (0.05 in/sec) max (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be attempting to lift an External Tank (ET) or the aft end of the orbiter from the stop position, releasing the brakes, the failure occurring, and the

- effect being the ET or the aft end of the orbiter descending and striking the VAB floor or transporter, resulting in possible damage to a vehicle system. Time to effect: seconds.
- b. Relay 1HCR will remain energized. Brake relays 1BR & 1BR1 will remain energized and the brakes will be released while no command is being initiated to move the load. The load will descend with regenerative braking at 0.25 ft/min (0.05 in/sec) max (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be floating an External Tank (ET) or the aft end of the orbiter releasing the foot switch to stop the float, the failure occurring, and the effect being the ET or the aft end of the orbiter descending and striking the VAB floor or transporter, resulting in possible damage to a vehicle system. Time to effect: seconds.
- c. The brakes will be released when the foot switch is engaged. The load will descend with regenerative braking at 0.25 ft/min (0.05 in/sec) max (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be engaging the foot switch to begin float operations for an External Tank (ET) or the aft end of the orbiter, the failure occurring prior to the operator supplying an input to the generator field DC input controller from FPOT, and the effect being the ET or the aft end of the orbiter descending and striking the VAB floor or transporter, resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Contact Ratings</u>	<u>Actual</u>
600 volts	120 volts

- Silver, double-break contacts.
- Internal parts enclosed for protection.
- This switch was off-the-shelf hardware selected by the crane manufacturer for this application.

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.
- OMI Q3008, Pre-Operation Setup Instructions, requires current limit checks prior to all major lifts of flight hardware (verifies motor, generator, generator field DC input controller, float control loop and DC power loop components are operational).

Inspection:

- OMI Q6003, Maintenance Instructions, requires annual inspection of switch contacts and contact members for burning, pitting, proper alignment, and discoloration caused by overheating.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by returning the Master Control Switch to neutral or pressing the E-Stop button.
 - 3) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 4) During all critical lifts, there is at least one Emergency Stop (E-Stop) operator remote from the operator's cab observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

SAA09FY12-006
REV. B

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Relay, Main Hoist

Find Number: 1RUN

Criticality Category: 2

SAA No: 09FY12-006

System/Area: 175-Ton Bridge Crane/VAB

NASA

PMN/ K60-0528/

Part No: NA

Name: 175-Ton Bridge Crane/VAB

Mfg/ Westinghouse/

Drawing/ 67-K-L-11348/

Part No: Type: M-011
Style: 493A571G01

Sheet No: 13, 15

Function: Energizes to allow input current from the generator field DC input controller to the generator field winding to move the DC drive motors.

Critical Failure Mode/Failure Mode No:

- a. 'Pull In' coil fails open/09FY12-006.018
- b. N.O. contact fails open OR N.C. contact fails closed/09FY12-006.019

Failure Cause:

- a. Corrosion, fatigue
- b. Corrosion, binding mechanism

Failure Effect: (For both failures) Generator field winding will not be energized. No output from the generator. No hoist motor torque while the command is being given to raise, lower or float the load and the brakes are released. The load will descend with regenerative braking at 0.25 ft/min (0.05 in/sec) max (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be attempting to lift or float an External Tank (ET) or the aft end of the orbiter from the stop position, releasing the brakes, the failure occurring, and the effect being the ET or the aft end of the orbiter descending and striking the VAB floor or transporter, resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Contact Ratings</u>	<u>Actual</u>
600 volts	109 volts max
150 amps	Testing required
<u>Coil Ratings</u>	<u>Actual</u>
600 volts	120 volts

- Contact material: silver.
- Coil can withstand 110% of rated voltage without burnout.
- This relay was off-the-shelf hardware selected by the crane manufacturer for this application.

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.

Inspection:

- OMI Q6003, Maintenance Instructions, requires annual inspection of relay contacts and contact members for burning, pitting, proper alignment, and discoloration caused by overheating; visual check of closing coils for deteriorated insulation and evidence of overheating or burning.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by returning the Master Control Switch to neutral or pressing the E-Stop button.
 - 3) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 4) During all critical lifts, there is at least one Emergency Stop (E-Stop) operator remote from the operator's cab observing the load lift, and can stop the crane if a failure indication is noticed.

- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Potentiometer, Main Hoist

Find Number: RPOT

Criticality Category: 2

SAA No: 09FY12-006

System/Area: 175-Ton Bridge Crane/VAB

NASA

PMN/ K60-0528/

Part No: NA

Name: 175-Ton Bridge Crane/VAB

Mfg/ Ohmite/

Drawing/ 67-K-L-11348/

Part No: RHS750

Sheet No: 15

Function: Reference potentiometer connected to the master control switch, 1MC, (joystick) to control the input excitation voltage to the generator field DC input controller, 1FC, and the resulting output to the generator field winding for main hoist speed control during raising or lowering operations.

Critical Failure Mode/Failure Mode No: Fails open/09FY12-006.022

Failure Cause: Corrosion, fatigue

Failure Effect: If the failure occurs on the wiper arm it would result in no generator field DC input controller excitation voltage and the resulting output to the generator field winding. No output from generator. No hoist motor torque while the command is being given, via the Master Control Switch to raise or lower and the brakes are released. The load will descend with regenerative braking at 0.25 ft/min (0.05 in/sec) max (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be attempting to lift an External Tank (ET) or the aft end of the orbiter from the stop position, releasing the brakes, the failure occurring, and the effect being the ET or the aft end of the orbiter descending and striking the VAB floor or transporter, resulting in possible damage to a vehicle system. Time to effect: seconds.

OR

If the failure occurs on the resistive element, it would result in a loss of the parallel resistance branch which will create a larger input into the generator field DC input controller which will cause an increasing speed of the DC motors controlling the main hoist. The worst case would be attempting to lower an External Tank (ET) or the aft end of the orbiter while in the coarse mode of operation, the failure occurring, causing a sudden increase to full coarse speed and the effect being the ET or the aft end of the orbiter striking the VAB floor or transporter, resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Rated Power</u>	<u>Actual Power</u>
25 watts	.18 watts
<u>Rated Voltage</u>	<u>Actual Voltage</u>
300 volts	12 volts
<u>Rated Current</u>	<u>Actual Current</u>
.176 amps	.015 amps

- Material:
 - Body: Ceramic
 - Windings: High grade resistance alloy
 - Coating: Vitreous enamel
 - Contact Arm: Metal graphite composition
 - Terminals: Solder coated
- Resistance tolerance: +/- 10 %

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.

Inspection:

- This item is not readily accessible for inspection. OMI Q6003, Maintenance Instructions, instructs that inspections shall not entail disassembly of equipment.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by returning the Master Control Switch to neutral or pressing the E-Stop button.

- 3) If the speed increase failure occurs in the fine speed mode of operation, the motor generator set will be shut down by an overvoltage protection relay when the voltage in the DC motor loop reaches 115% of full fine voltage.
 - 4) Operationally, the crane must be operated in the fine speed mode if a critical load is within 10 feet of any structure.
 - 5) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 6) During all critical lifts, there is at least one remote Emergency Stop (E-Stop) operator observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Resistor, Main Hoist (2 total)
Find Number: 1RR4A, 1RR4B (1ea)
Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA		PMN/	K60-0528/
Part No:	NA	Name:	175-Ton Bridge Crane/VAB
Mfg/	DIGI-KEY/	Drawing/	67-K-L-11348/
Part No:	P 1.6KW-2	Sheet No:	15

Function: Provides a voltage divider for the +/- 6VDC power source to the potentiometer, R-POT, in the master controller (joystick), 1MC, for input to the generator field DC input controller, 1FC, to allow for main hoist operation in the fine speed mode.

Critical Failure Mode/Failure Mode No: Fails open/09FY12-006.065

Failure Cause: Contamination, corrosion, fatigue

Failure Effect: No generator field DC input controller excitation voltage in the fine speed mode of operation. No generator field winding voltage. No output from the generator. No hoist motor torque when the command is given, via the master control switch to raise or lower the load while the brakes are released. The load will descend with regenerative braking at 0.25 ft/min (0.05 in/sec) max (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be attempting to lift an External Tank (ET) or the aft end of the orbiter from the stop position, releasing the brakes, the failure occurring, and the effect being the ET or the aft end of the orbiter descending and striking the VAB floor or transporter, resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

- 1600 Ohm Resistor
- 5% Metal Oxide Film Resistor
- Resistance tolerance: +/- 5%.
- Meets overload tests in accordance with UL (Underwriters Laboratories) specification #1412 without producing a fire hazard.
- Withstands solvents in accordance with Mil-Std-202E without producing mechanical or electrical damage.

- Temperature coefficient: +/- 100 PPM/°C typ., +/- 200 PPM/°C max.
- Maximum working voltage: 350 volts
- Actual working voltage: 6 volts
- Rated power: 2 watts
- Actual power: 0.0082 watts

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.

Inspection:

- OMI Q6003, Maintenance Instructions, requires annual inspection of resistors for deterioration/discoloration caused by corrosion or overheating.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failures can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by returning the Master Control Switch to neutral or pressing the E-Stop button.
 - 3) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 4) During all critical lifts, there is at least one remote Emergency Stop (E-Stop) operator observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Potentiometer, Main Hoist
Find Number: FPOT
Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA		PMN/	K60-0528/
Part No:	NA	Name:	175-Ton Bridge Crane/VAB
Mfg/	Ohmite/	Drawing/	67-K-L-11348/
Part No:	RHS750	Sheet No:	15

Function: Controls the input excitation voltage to the generator field DC input controller, 1FC, and the resulting output to the generator field winding for main hoist control during float operations.

Critical Failure Mode/Failure Mode No: Fails open/09FY12-006.025

Failure Cause: Corrosion, fatigue

Failure Effect: If the failure occurs on the wiper arm it would result in no generator field DC input controller excitation voltage and the resulting output to the generator field winding. No output from generator. No hoist motor torque while the command is being given to float and the brakes are released. The load will descend with regenerative braking at 0.25 ft/min (0.05 in/sec) max (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be attempting to float an External Tank (ET) or the aft end of the orbiter from the stop position, releasing the brakes, the failure occurring, and the effect being the ET or the aft end of the orbiter descending and striking the VAB floor or transporter, resulting in possible damage to a vehicle system. Time to effect: seconds.

OR

If the failure occurs on the resistive element, it would result in a loss of the parallel resistance branch which will create a larger input into the generator field DC input controller which will cause an increasing input to the DC motors controlling the main hoist. The worst case would be floating an External Tank (ET) or the aft end of the orbiter (near zero vertical speed), the failure occurring, causing an inadvertent movement of the load and the effect being the ET or the aft end of the orbiter descending and striking the VAB floor or transporter, resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Rated Power</u>	<u>Actual Power</u>
25 watts	.18 watts
<u>Rated Voltage</u>	<u>Actual Voltage</u>
300 volts	12 volts
<u>Rated Current</u>	<u>Actual Current</u>
.176 amps	.015 amps

- Material:
 - Body: Ceramic
 - Windings: High grade resistance alloy
 - Coating: Vitreous enamel
 - Contact Arm: Metal graphite composition
 - Terminals: Solder coated
- Resistance tolerance: +/- 10 %

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.
- OMI Q3008, Pre-Operation Setup Instructions, requires current limit checks prior to all major lifts of flight hardware (verifies motor, generator, generator field DC input controller float control loop and DC power loop components are operational).

Inspection:

- This item is not readily accessible for inspection. OMI Q6003, Maintenance Instructions, instructs that inspections shall not entail disassembly of equipment.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by releasing the brake switch or pressing the E-Stop button.
 - 3) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 4) During all critical lifts, there is at least one Emergency Stop (E-Stop) operator remote from the operator's cab observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Resistor, Main Hoist
Find Number: 1RR7
Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA		PMN/	K60-0528/
Part No:	NA	Name:	175-Ton Bridge Crane/VAB
Mfg/	DIGI-KEY/	Drawing/	67-K-L-11348/
Part No:	P 56KW-2	Sheet No:	15

Function: Provides a voltage divider for the input from the float potentiometer, F POT, to the generator field DC input controller, 1FC, to allow for main hoist operation in the float mode.

Critical Failure Mode/Failure Mode No: Fails open/09FY12-006.066

Failure Cause: Contamination, corrosion, fatigue

Failure Effect: No generator field DC input controller excitation voltage in the float mode of operation. No generator field winding voltage. No output from the generator. No hoist motor torque when the command is given to float the load while the brakes are released, via the brake switch. The load will descend with regenerative braking at 0.25 ft/min (0.05 in/sec) max (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be floating an External Tank (ET) or the aft end of the orbiter (near zero vertical speed), releasing the brakes, the failure occurring, and the effect being the ET or the aft end of the orbiter descending and striking the VAB floor or transporter, resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

- 56000 Ohm Resistor
- 5% Metal Oxide Film Resistor
- Resistance tolerance: +/- 5%.
- Meets overload tests in accordance with UL (Underwriters Laboratories) specification #1412 without producing a fire hazard.
- Withstands solvents in accordance with Mil-Std-202E without producing mechanical or electrical damage.
- Temperature coefficient: +/- 100 PPM/°C typ., +/- 200 PPM/°C max.

- Maximum working voltage: 350 volts
- Actual working voltage: 6 volts
- Rated power: 2 watts
- Actual power: 0.00064 watts

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.
- OMI Q3008, Pre-Operation Setup Instructions, requires current limit checks prior to all major lifts of flight hardware (verifies motor, generator, generator field DC input controller float control loop and DC power loop components are operational).

Inspection:

- OMI Q6003, Maintenance Instructions, requires annual inspection of resistors for deterioration/discoloration caused by corrosion or overheating.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failures can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by releasing the brake switch, or pressing the E-Stop button.
 - 3) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 4) During all critical lifts, there is at least one remote Emergency Stop (E-Stop) operator observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Meter Relay, Main Hoist

Find Number: M1

Criticality Category: 2

SAA No: 09FY12-006

System/Area: 175-Ton Bridge Crane/VAB

NASA

PMN/

K60-0528/

Part No: NA

Name:

175-Ton Bridge Crane/VAB

Mfg/ Larson Instrument Co./

Drawing/

67-K-L-11348/

Part No: CMC 3.5 4-L

Sheet No:

15

Function: Controls relay K10 to scale current reading on the console ammeter by a factor of 10 when the hoist motors current reaches 60 amps. Also controls console light PL34 to indicate to operator when current reading is scaled.

Critical Failure Mode/Failure Mode No:

High/low limit No. 2 N.C. contact fails open/09FY12-006.029

Failure Cause: Corrosion, binding mechanism

Failure Effect: Relay K10 will not be energized and the current reading on the console ammeter will be scaled without indication from console light PL34. This could lead to an operator giving erroneous input during float operations resulting in an inadvertent movement of the load. Possible damage to vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Rating</u>	<u>Actual</u>
115 volts	120 volts

- This relay was off-the-shelf hardware selected by the crane manufacturer for this application.

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMRSD File VI requires verification of proper performance of console ammeter switch-over point (main hoist-60A, aux. hoist-20A) annually.

- OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.

Inspection:

- This is a self-contained unit with contacts that are not readily accessible for inspection. OMI Q6003, Maintenance Instructions, instructs that inspections shall not entail disassembly of equipment.

Failure History:

- The PRACA database was researched and failure data was found on this component in the critical failure mode.
 - The failures occurred on 7/23/91, 8/14/91, and 10/3/91.
 - The failure cause was binding mechanism.
 - The correcting action was remove and replace the relay.

NOTE: These failures did not necessarily occur on this crane drive system. The failure may have occurred on either the main or auxiliary hoist drive systems of this crane or one of the two VAB 250-Ton Bridge Cranes.

- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via a Selsyn (inadvertent movement) that is in view of both operators.
 - 2) Operator can stop all crane operations, when the failure indication is noticed, by returning the master control switch to neutral, by releasing the brake switch or pressing the E-Stop button.
 - 3) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 4) During all critical lifts, there is at least one Emergency Stop (E-Stop) operator remote from the operator's cab observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Relay, Main Hoist

Find Number: K10

Criticality Category: 2

SAA No: 09FY12-006

System/Area: 175-Ton Bridge Crane/VAB

NASA

PMN/ K60-0528/

Part No: NA

Name: 175-Ton Bridge Crane/VAB

Mfg/ Potter-Brumfield/

Drawing/ 67-K-L-11348/

Part No: KHP 17411

Sheet No: 15

Function: Energized when hoist motors are drawing less than 60 amps. Contact is closed to allow the console ammeter to display actual current. De-energized when current reaches 60 amps to scale the current reading on the console ammeter by a factor of 10.

Critical Failure Mode/Failure Mode No:

- a. Coil fails open/09FY12-006.030
- b. N.O. contact fails open/09FY12-006.031

Failure Cause:

- a. Corrosion, fatigue
- b. Corrosion, binding mechanism

Failure Effect: (For both failures) The current reading on the console ammeter will be scaled without indication from console light PL34. This could lead to an operator giving an erroneous input during float operations resulting in an inadvertent movement of the load. Possible damage of a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Coil Rating</u>	<u>Actual</u>
240 volts	120 volts

- Contact material: Silver
- Expected mechanical life of 10 million operations.
- This relay was off-the-shelf hardware selected by the crane manufacturer for this application.

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMRSD File VI requires verification of proper performance of console ammeter switch-over point (main hoist-60A, aux. hoist-20A) annually.
- OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.

Inspection:

- OMI Q6003, Maintenance Instructions, requires annual inspection of relay contacts and contact members for burning, pitting, proper alignment, and discoloration caused by overheating. Visually check closing coils for deteriorated insulation and evidence of overheating or burning.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via a Selsyn (inadvertent movement) that is in view of both operators.
 - 2) Operator can stop all crane operations, when the failure indication is noticed, by returning the master control switch to neutral, by releasing the brake switch or pressing the E-Stop button.
 - 3) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 4) During all critical lifts, there is at least one Emergency Stop (E-Stop) operator remote from the operator's cab observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Relay, Main Hoist

Find Number: 1VR

Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA		PMN/	K60-0528/
Part No:	NA	Name:	175-Ton Bridge Crane/VAB
Mfg/	General Electric/	Drawing/	67-K-L-11348/
Part No:	1C2820 A1D0 AB2E	Sheet No:	13, 15

Function: Monitors voltage in the main hoist motor loop and provides latching to keep relays 1HCR or 1LCR energized after master control switch, 1MC, is returned to neutral position. This prevents the brakes from setting while voltage in the motor loop is above a predetermined limit.

Critical Failure Mode/Failure Mode No: N.O. contact fails closed/09FY12-006.033

Failure Cause: Welded contact, binding mechanism

Failure Effect: Brake relays will remain energized and the brakes will not set when main hoist motors are commanded to stop via the Master Control Switch. The load will descend with regenerative braking at 0.25 ft/min (0.05 in/sec) max (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be attempting to bring an External Tank (ET) or the aft end of the orbiter to a stop while hoisting or lowering, the failure occurring, and the effect being the ET or the aft end of the orbiter descending and striking the VAB floor or transporter, resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Ratings</u>	<u>Actual</u>
600 volts	120 volts
10 amps	Testing required

- Contact Material: Silver Cadmium Oxide, Self-cleaning.
- This relay was off-the-shelf hardware selected by the crane manufacturer for this application.

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.

Inspection:

- OMI Q6003, Maintenance Instructions, requires annual inspection of contacts and contact members for burning, pitting, proper alignment, and discoloration caused by overheating; visual check of closing coils for deteriorated insulation and evidence of overheating or burning.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by pressing the E-Stop button.
 - 3) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 4) During all critical lifts, there is at least one Emergency Stop (E-Stop) operator remote from the operator's cab observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Relay, Main Hoist

Find Number: 1KR

Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA	NA	PMN/	K60-0528/
Part No:		Name:	175-Ton Bridge Crane/VAB
Mfg/	General Electric/	Drawing/	67-K-L-11348/
Part No:	CR105CO, NEMA Size 1	Sheet No:	12, 13, 15

Function: The relay energizes when power is applied to the hoist motor-generator set closing the normally open (N.O.) contact to energize relay 1SRX. Relay 1SRX contact closes to bypass resistor RES A which allows an increase in current to the DC motor field windings to strengthen the field for normal operations.

Critical Failure Mode/Failure Mode No: N.O. Contact Fails Open/09FY12-006.095

Failure Cause: Corrosion, binding mechanism

Failure Effect: The N.O. contact will be open to deenergize relay 1SRX. This places resistor RES A in series with the DC motor field windings. The field will be weakened by the reduction of current through the windings. The hoist will descend at a higher rate of speed than expected (speed will be approximately double of the commanded input). The worst case scenario would be lowering an External Tank (ET) or the aft end of an orbiter in the coarse speed mode (maximum coarse speed is 10 ft/min), the failure occurring causing the hoist speed to increase to approximately two times the commanded speed, resulting in the ET or the aft end of the orbiter striking the VAB floor or transporter resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Contact Ratings</u>	<u>Actual</u>
600 volts	183 volts
30 amps	Testing required

- Contact Material: Silver Cadmium Oxide.
- This relay was off-the-shelf hardware selected by the crane manufacturer for this application.

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems to be operated briefly in all speeds to verify satisfactory operation before lifting operations.

Inspection:

- OMI Q6003, Maintenance Instructions, requires annual inspection of contacts and contact members for burning, pitting, proper alignment, and discoloration caused by overheating; visual check of closing coils for deteriorated insulation and evidence of overheating or burning.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by pressing the E-Stop button.
 - 3) Operationally, the crane must be operated in the fine or float speed mode if a critical load is within 10 feet of any structure.
 - 4) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 5) During all critical lifts, there is at least one remote Emergency Stop (E-Stop) operator observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Relay, Main Hoist

Find Number: 1SRX

Criticality Category: 2

SAA No: 09FY12-006

System/Area: 175-Ton Bridge Crane/VAB

NASA NA

PMN/ K60-0528/

Part No:

Name: 175-Ton Bridge Crane/VAB

Mfg/ General Electric/

Drawing/ 67-K-L-11348/

Part No: IC28001607F2

Sheet No: 12

Function: The relay energizes when power is applied to the hoist motor-generator set, closing the normally open (N.O.) contact to allow an increase in current to the DC motor field windings to strengthen the field for normal operations.

The relay is deenergized while in the high speed mode, which opens the contacts, to place resistor RES A in series with the field windings to reduce the current and weaken the field.

Critical Failure Mode/Failure Mode No:

- a. Coil Fails Open/09FY12-006.101
- b. N.O. Contact Fails Open/09FY12-006.102

Failure Cause:

- a. Corrosion, fatigue
- b. Corrosion, binding mechanism

Failure Effect: (For both failures) The N.O. contact will be opened placing resistor RES A in series with the DC motor field windings. The field will be weakened by the reduction of current through the windings. The hoist will descend at a higher rate of speed than expected (speed will be approximately double of the commanded input). The worst case scenario would be lowering an External Tank (ET) or the aft end of an orbiter in the coarse speed mode (maximum coarse speed is 10 ft/min), the failure occurring causing the hoist speed to increase to approximately two times the commanded speed, resulting in the ET or the aft end of the orbiter striking the VAB floor or transporter resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Contact Ratings</u>	<u>Actual</u>
600 volts	183 volts
25 amps	14 amps

- This relay was off-the-shelf hardware selected by the crane manufacturer for this application.

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems to be operated briefly in all speeds to verify satisfactory operation before lifting operations.

Inspection:

- OMI Q6003, Maintenance Instructions, requires annual inspection of contacts and contact members for burning, pitting, proper alignment, and discoloration caused by overheating; visual check of closing coils for deteriorated insulation and evidence of overheating or burning.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by pressing the E-Stop button.
 - 3) Operationally, the crane must be operated in the fine or float speed mode if a critical load is within 10 feet of any structure.
 - 4) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 5) During all critical lifts, there is at least one remote Emergency Stop (E-Stop) operator observing the load lift, and can stop the crane if a failure indication is noticed.

- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Generator Field DC Input Controller, Main Hoist

Find Number: 1FC

Criticality Category: 2

SAA No: 09FY12-006

System/Area: 175-Ton Bridge Crane/VAB

NASA

PMN/ K60-0528/

Part No: NA

Name: 175-Ton Bridge Crane/VAB

Mfg/ Reflex/

Drawing/ 67-K-L-11348/

Part No: URRK-VIII

Sheet No: 15

Function: A solid state assembly which provides DC excitation to the generator field of the motor-generator set (M12-G4). The excitation is proportional to the input supplied from the control potentiometers (R POT, F POT) and is used to drive the DC motors which control the main hoist.

Critical Failure Mode/Failure Mode No:

- a. No output/09FY12-006.067
- b. High output (not inverted)/09FY12-006.072
- c. High output (inverted)/09FY12-006.073

Failure Cause:

- a. Contamination, corrosion, board component open.
- b. Board component short, board component open, loss of voltage feedback from the DC drive motor loop.
- c. Board component short.

Failure Effect:

- a. No DC excitation voltage to the generator field winding. No output from the generator. No hoist motor torque when the command is given to raise, lower, or float the load while the brakes are released. The load will descend with regenerative braking at 0.25 ft/min (0.05 in/sec) max (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be attempting to lift an External Tank (ET) or the aft end of the orbiter from the stop position, releasing the brakes, the failure occurring, and the effect being the ET or the aft end of the orbiter descending and striking the VAB floor or transporter, resulting in possible damage to a vehicle system. Time to effect: seconds.

- b. Increasing speed of the DC motors controlling the main hoist. The worst case would be attempting to lower an ET or the aft end of the orbiter in the slow coarse mode of operation, the failure occurring causing a sudden increase to full coarse speed resulting the ET or the orbiter striking the VAB floor or transporter at a velocity of 10 ft/min causing possible damage to a vehicle system. Time to effect: seconds.
- c. Increasing speed, in the opposite direction than commanded, of the DC motors controlling the main hoist. The worst case would be attempting to lift an ET or the aft end of the orbiter in the slow coarse mode of operation, the failure occurring causing a sudden increase to full coarse speed downward resulting the ET or the orbiter striking the VAB floor or transporter at a velocity of 10 ft/min causing possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

- Voltage feedback from the DC motor armature loop maintains a constant output to the drive motors at $\pm 2\%$. This prevents an overvoltage condition from driving the crane faster than is commanded by the operator.
- Current feedback from the DC motor armature loop prevents the crane from being driven faster than is allowable in maximum coarse speed.
- Current feedback from the generator field winding maintains the proper gating for output to the generator field.
- Output can be regulated and will remain constant each time the crane is being used. This allows for uniformity in expected crane reactions to inputs from the operator.
- Output to the generator field is supplied up to positive or negative 109 volts in response to an input of positive or negative 6 volts.
- Rated power: 4K watts
- Actual power: 2K watts
- Rated temperature: 0 to 50° C.
- Actual temperature: Ambient.

Test:

- a. OMRSD file VI requires verification of proper performance of hoist operational test annually.
- b. OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.
- c. OMI Q3008, Pre-Operation Setup Instructions, requires current limit checks prior to all major lifts of flight hardware (verifies motor, generator, generator field DC input controller, float control loop and DC power loop components are operational).
- d. OMI Q3008, Pre-Operation Setup Instructions, requires a verification of proper operation of the overvoltage protection relays prior to all critical lifts.

Inspection:

- OMI Q6003, Maintenance Instructions, will require an annual visual inspection of the solid state circuit board assemblies for evidence of burning, discoloration caused by overheating, contamination or corrosion.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by returning the Master Control Switch to neutral or pressing the E-Stop button (releasing the brake switch in float mode).
 - 3) When the high output failure occurs in the fine speed or float mode, the motor generator set will be shut down by an overvoltage protection relay when the voltage in the DC motor loop reaches 115% of full float voltage in the float mode, or 115% of full fine voltage in the fine mode (see Test item d for operational verification information).
 - 4) Operationally, the crane must be operated in the fine or float speed mode if a critical load is within 10 feet of any structure.
 - 5) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 6) During all critical lifts, there is at least one remote Emergency Stop (E-Stop) operator observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Relay, Main Hoist
Find Number: 1XR1
Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA		PMN/	K60-0528/
Part No:	NA	Name:	175-Ton Bridge Crane/VAB
Mfg/	Allen Bradley/	Drawing/	67-K-L-11348/
Part No:	700-P400A1	Sheet No:	13, 15

Function: Enables the generator field DC input controller, 1FC, when relay 1HCR or 1LCR is energized.

Critical Failure Mode/Failure Mode No:

- a. Coil fails open/09FY12-006.068
- b. N.O. contact fails open/09FY12-006.069
- c. N.O. contact fails open/09FY12-006.070
- d. N.O. contact fails open/09FY12-006.071

Failure Cause:

- a. Corrosion, fatigue
- b. Corrosion, binding mechanism
- c. Corrosion, binding mechanism
- d. Corrosion, binding mechanism

Failure Effect:

- a. The contacts will remain deenergized. No DC excitation voltage to the generator field winding. No output from the generator. No hoist motor torque when the command is given to raise, lower, or float the load while the brakes are released. The load will descend with regenerative braking at 0.25 ft/min (0.05 in/sec) max (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be attempting to lift an External Tank (ET) or the aft end of the orbiter from the stop position, releasing the brakes, the failure occurring, and the effect being the ET or the aft end of the orbiter descending and striking the VAB floor or transporter, resulting in possible damage to a vehicle system. Time to effect: seconds.

- b. The speed regulator in the generator field DC input controller will not be enabled. No DC excitation voltage to the generator field winding. No output from the generator. No hoist motor torque when the command is given to raise, lower, or float the load while the brakes are released. The load will descend with regenerative braking at 0.25 ft/min (0.05 in/sec) max (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be attempting to lift an External Tank (ET) or the aft end of the orbiter from the stop position, releasing the brakes, the failure occurring, and the effect being the ET or the aft end of the orbiter descending and striking the VAB floor or transporter, resulting in possible damage to a vehicle system. Time to effect: seconds.
- c. The bi-directional amplifier in the generator field DC input controller will not be enabled. No DC excitation voltage to the generator field winding. No output from the generator. No hoist motor torque when the command is given to raise, lower, or float the load while the brakes are released. The load will descend with regenerative braking at 0.25 ft/min (0.05 in/sec) max (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be attempting to lift an External Tank (ET) or the aft end of the orbiter from the stop position, releasing the brakes, the failure occurring, and the effect being the ET or the aft end of the orbiter descending and striking the VAB floor or transporter, resulting in possible damage to a vehicle system. Time to effect: seconds.
- d. The firing circuit in the generator field DC input controller will not be enabled. No DC excitation voltage to the generator field winding. No output from the generator. No hoist motor torque when the command is given to raise, lower, or float the load while the brakes are released. The load will descend with regenerative braking at 0.25 ft/min (0.05 in/sec) max (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be attempting to lift an External Tank (ET) or the aft end of the orbiter from the stop position, releasing the brakes, the failure occurring, and the effect being the ET or the aft end of the orbiter descending and striking the VAB floor or transporter, resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

- Contact Voltage Rating: 600 VDC
- Contact Voltage Actual: 15 VDC
- Contact Material: Nickel Silver (Ni Ag)
- Coil Voltage Rating: 600 VAC
- Coil Voltage Actual: 120 VAC
- Coil Power Rating: 20 VA 60 Hz (sealed), 138 VA 60 Hz (inrush)
- Pickup Time: 20 msec
- Dropout Time: 20 msec
- Rated Operating Temperature: -20°C to +40°C

- Actual Operating Temperature: Ambient
- UL (Underwriters Laboratory) listed

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.
- OMI Q3008, Pre-Operation Setup Instructions, requires current limit checks prior to all major lifts of flight hardware (verifies motor, generator, generator field DC input controller, float control loop and DC power loop components are operational).

Inspection:

- OMI Q6003, Maintenance Instructions, requires annual inspection of contacts and contact members for burning, pitting, proper alignment, and discoloration caused by overheating; visual check of closing coils for deteriorated insulation and evidence of overheating or burning.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by returning the Master Control Switch to neutral or pressing the E-Stop button (releasing the brake switch in the float mode).
 - 3) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 4) During all critical lifts, there is at least one remote Emergency Stop (E-Stop) operator observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Synchro Transmitter and Receiver Assembly, Main Hoist
Find Number: 1SYNT/1SYNR1
Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA		PMN/	K60-0528/
Part No:	NA	Name:	175-Ton Bridge Crane/VAB
Mfg/	General Electric/	Drawing/	67-K-L-11348/
Part No:	2JDA66PA10A, 5PY-5GTY23	Sheet No:	16

Function: Provides main hoist position and motion indication to the operator in the cab. The operator uses this indicator to determine movement distance when required to make small incremental moves for mate/demate operations.

Critical Failure Mode/Failure Mode No: Erroneous Output (indication)/09FY12-006.103

Failure Cause: Corrosion, binding mechanism

Failure Effect: Loss of accurate position indication or load motion indication could result in improper load positioning. The worst case would be attempting to mate or demate an External Tank (ET) or the aft end of the orbiter from the transporter, the failure occurring, and the effect being the operator commanding too much movement and the ET or orbiter contacting the transporter. Possible damage to vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Ratings</u>	<u>Actual</u>
115 volts	120 volts

- Totally enclosed nonventilated cast housing.
- Motor-type rotor is the only moving part.
- This item was off-the-shelf hardware selected by the crane manufacturer for this application.

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.

- OMI Q3008, Operating Instructions, requires all crane systems to be operated briefly in all speeds to verify satisfactory operation before lifting operations.

Inspection:

- OMI Q6003, Maintenance Instructions, require monthly inspection for quietness and smoothness during operation; monthly inspection of belt drives for worn, frayed or abnormal wear; monthly inspection for broken, bent or badly worn pulleys; monthly verification by examination and manipulation that keys and couplings are securely in place; annual removal and inspection of brushes and replacement of brushes when overall length is 3/8-inch or less.

Failure History:

- The PRACA database was researched and failure data was found on this component in the critical failure mode.
 - The failures occurred on 3/9/91, 10/10/91, and 10/8/92.
 - The failure cause was binding mechanism.
 - The correcting action was to remove and replace the selsyn receiver (3/9/91), or to remove, repair and replace the selsyn receiver (10/10/91 & 10/8/92).

NOTE: These failures did not necessarily occur on this crane drive system. The failure may have occurred on any one of the drive systems of this crane or one of the two VAB 250-Ton Bridge Cranes.

- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) When the failure indication is noticed, the operator can stop all crane operations by returning the Master Control Switch to neutral or pressing the E-Stop button (releasing the brake switch in the float mode).
 - 2) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 3) During all critical lifts, there is at least one remote Emergency Stop (E-Stop) operator observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Motor - Generator Set, Aux Hoist

Find Number: M9-G3

Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA		PMN/	K60-0528/
Part No:	NA	Name:	175-Ton Bridge Crane/VAB
Mfg/	Motor: Imperial Electric/	Drawing/	67-K-L-11348/
Part No:	Type E Form C	Sheet No:	18
	Gen: Imperial Electric/		
	Type D Form C		

Function: Consists of a 150 HP motor coupled to a 85 KW DC generator to provide power to the armatures of the two 40 HP auxiliary hoist motors.

Critical Failure Mode/Failure Mode No: No output/09FY12-006.035

Failure Cause: Brush/commutator failure, open/shorted armature winding, structural failure (brush spring, brush yoke, brush rigging), open/shorted field winding.

Failure Effect: Loss of auxiliary hoist motor armature current. Loss of auxiliary hoist motor torque while the command is being given to raise, lower, or float and the brakes are released. The load will drop without regenerative braking. The worst case would be the forward assembly being hoisted, lowered, or floated the failure occurring, and the effect being the forward assembly descending and striking the VAB floor or platform causing possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Motor</u>	<u>Gen</u>
150 HP	85 KW
480 VAC	480 VDC
1750 rpm	1750 rpm
150 A	172 A

- This was designed for crane use and selected by the crane manufacturer for this application.

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.
- OMI Q3008, Pre-Operation Setup Instructions, requires current limit checks prior to all major lifts of flight hardware (verifies motor, generator, generator field DC input controller, float control loop and DC power loop components are operational).

Inspection:

- OMI Q3008 Pre-Operation Setup Instructions require visual and audible check of commutators on motor-generator set generator for proper operation and condition.
- OMI Q6003, Maintenance Instructions, requires semiannual inspection of brushes on motor-generator set generators for freedom of movement, wear, clearance, security and cleanliness.
- OMI Q6003, Maintenance Instructions, requires semiannual inspection of motor-generator set motors and motor-generator set generators for acceptable condition or damage.
- OMI Q6003, Maintenance Instructions, requires semiannual inspection of armature loop insulation resistance at each motor-generator set.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failures can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by pressing the E-Stop button.
 - 3) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 4) During all critical lifts, there is at least one remote Emergency Stop (E-Stop) operator observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

SAA09FY12-006
REV. B

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: DC Motor, Auxiliary Hoist (2 total)
Find Number: M10, M11 (1 ea)
Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA		PMN/	K60-0528/
Part No:	NA	Name:	175-Ton Bridge Crane/VAB
Mfg/	Imperial Electric/	Drawing/	67-K-L-11348/
Part No:	Type DV, Form C, Frame: D69Z	Sheet No:	19

Function: Two 40 HP shunt wound DC motors with the armatures arranged in series to provide mechanical torque to raise, lower or float the load. The field windings, F1-F2 & F3-F4, provide a constant magnetic field to work against the varying magnetic field of the armature loop to produce torque.

Critical Failure Mode/Failure Mode No: Open armature winding/09FY12-006.063

Failure Cause: Brush/commutator failure, open/shorted armature winding, structural failure (brush spring, brush yoke, brush rigging).

Failure Effect: Loss of armature DC current to both motors. Loss of auxiliary hoist motor torque while the command is given to raise, lower or float load and the brakes are released. The load will drop without regenerative braking. The worst case would be the forward assembly being hoisted, lowered, or floated, the failure occurring, and the effect being the forward assembly descending and striking the VAB floor or platform causing possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

- 40 HP
- 240 VDC (2 motors arranged in series with the 480 VDC generator)
- 144 A
- 500-1500 RPM
- Field and armature arranged in shunt configuration.
- This was designed for crane use and selected by the crane manufacturer for this application.

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.
- OMI Q3008, Pre-Operation Setup Instructions, requires current limit checks prior to all major lifts of flight hardware (verifies motor, generator, generator field DC input controller, float control loop and DC power loop components are operational).

Inspection:

- OMI Q3008 Pre-Operation Setup Instructions require visual and audible check of commutators on auxiliary hoist drive motors for proper operation and condition.
- OMI Q6003, Maintenance Instructions, requires semiannual inspection of brushes on auxiliary hoist drive motors for freedom of movement, wear, clearance, security and cleanliness.
- OMI Q6003, Maintenance Instructions, requires semiannual inspection of auxiliary hoist drive motors for acceptable condition or damage.
- OMI Q6003, Maintenance Instructions, requires semiannual inspection of armature loop insulation resistance at each motor.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failures can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by pressing the E-Stop button.
 - 3) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 4) During all critical lifts, there is at least one remote Emergency Stop (E-Stop) operator observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Master Control Switch, Aux Hoist
Find Number: 2MC
Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA		PMN/	K60-0528/
Part No:	NA	Name:	175-Ton Bridge Crane/VAB
Mfg/	General Electric/	Drawing/	67-K-L-11348/
Part No:	1C3012-K-620-D6	Sheet No:	17

Function: A "joystick" connected to mechanical contacts and reference potentiometer (RPOT), to provide the operator control of the aux hoist for raising or lowering the load and releasing the brakes by energizing the hoist control or lower control relays in the normal mode of operation.

Critical Failure Mode/Failure Mode No: N.O. contacts fail closed/09FY12-006.036

Failure Cause: Welded contact, binding mechanism

Failure Effect: Brakes will not set when master control lever is returned to neutral position (no motor armature current). The load will descend with regenerative braking at 1.7 ft/min (0.34 in/sec) max (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be attempting to bring a forward assembly to a stop while hoisting or lowering, the failure occurring, and the effect being the forward assembly descending and striking the VAB floor or platform, resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

- Double-break silver alloy contacts.
- Phenolic cams impregnated with graphite for self-lubrication to allow for millions of operations without significant wear.
- This switch was off-the-shelf hardware selected by the crane manufacturer for this application.

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.

Inspection:

- OMI Q6003, Maintenance Instructions, requires annual inspection of switch contacts and contact members for burning, pitting, proper alignment, and discoloration caused by overheating.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via a brake set light or Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by pressing the E-Stop button.
 - 3) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 4) During all critical lifts, there is at least one Emergency Stop (E-Stop) operator remote from the operator's cab observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

Critical Item: Relay, Aux Hoist (2 ea)
Find Number: 2HCR, 2LCR (1 ea)
Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA		PMN/	K60-0528/
Part No:	NA	Name:	175-Ton Bridge Crane/VAB
Mfg/	General Electric/	Drawing/	67-K-L-11348/
Part No:	CR120A06002AA	Sheet No:	17

Function: Provides power to brake relays to release brakes during hoisting, lowering, float operations, and provides power to start the sequence to energize the generator field winding.

- a. N.O. contact closes to energize HCR RUN (2HCR) or LCR RUN (2LCR) which energizes relay 2RUN.
- b. N.O. contact closes to energize relay 2XR, which releases the brakes, and relay 2XR1, which enables the generator field DC input controller.

Critical Failure Mode/Failure Mode No:

- a. N.O. contact fails open/
 - 09FY12-006.037 (2HCR)
 - 09FY12-006.039 (2LCR)
- b. N.O. contact fails closed/
 - 09FY12-006.038 (2HCR)
 - 09FY12-006.040 (2LCR)

Failure Cause:

- a. Corrosion, binding mechanism.
- b. Welded contacts, binding mechanism.

Failure Effect:

- a. Relay 2RUN N.O. contact will not close and generator field will not be energized. No output from the generator. No hoist motor torque while the command is being given to raise, lower or float the load and the brakes are released. The load will descend with regenerative braking at 1.7 ft/min (0.34 in/sec) max (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be attempting to

lift or float a forward assembly from the stop position, releasing the brakes, the failure occurring, and the effect being the forward assembly descending and striking the VAB floor or platform, resulting in possible damage to a vehicle system. Time to effect: seconds.

- b. Brake relays will remain energized and the brakes will not set when the hoist motors are commanded to stop (in normal operation). The load will descend with regenerative braking at 1.7 ft/min (0.34 in/sec) max (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be attempting to bring a forward assembly to a stop while lowering, the failure occurring, and the effect being the forward assembly continuing to lower, resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Contact Ratings</u>	<u>Actual</u>
300 volts	120 volts
10 amps	Testing required

- Contact Material: Silver Cadmium Oxide, Self-cleaning
- Mechanical life expectancy is 10 million operations.
- This relay was off-the-shelf hardware selected by the crane manufacturer for this application.

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.

Inspection:

- OMI Q6003, Maintenance Instructions, requires annual inspection of contacts and contact members for burning, pitting, proper alignment, and discoloration caused by overheating; visual check of closing coils for deteriorated insulation and evidence of overheating or burning.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via the brake set light or Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by returning the Master Control Switch to neutral or pressing the E-Stop button (releasing the brake switch in the float mode).
 - 3) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 4) During all critical lifts, there is at least one remote Emergency Stop (E-Stop) operator observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Relay, Aux Hoist
Find Number: 2HS
Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA	NA	PMN/	K60-0528/
Part No:		Name:	175-Ton Bridge Crane/VAB
Mfg/	General Electric/	Drawing/	67-K-L-11348/
Part No:	CR120A06002AA	Sheet No:	17

Function: The relay energizes to open the normally closed (N.C.) contact which deenergizes relay 2FW to allow the hoist to operate in the high speed mode.

Critical Failure Mode/Failure Mode No: Contact Fails Open/09FY12-006.105

Failure Cause: Corrosion, binding mechanism

Failure Effect: The N.C. contact will open, deenergizing relay 2FW, which places resistors 2FWR and RES A in series with the DC motor field windings. The field will be weakened by the reduction of current through the windings. The hoist will be in the high speed mode configuration. The worst case scenario would be lowering a forward assembly in the coarse speed mode (maximum coarse speed is 25 ft/min), the failure occurring causing the hoist speed to increase to approximately three times the commanded speed, resulting in the forward assembly striking the VAB floor or platform resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Contact Ratings</u>	<u>Actual</u>
300 volts	120 volts
10 amps	Testing required

- Contact Material: Silver Cadmium Oxide, Self-cleaning
- Mechanical life expectancy is 10 million operations.
- This relay was off-the-shelf hardware selected by the crane manufacturer for this application.

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems to be operated briefly in all speeds to verify satisfactory operation before lifting operations.

Inspection:

- OMI Q6003, Maintenance Instructions, requires annual inspection of contacts and contact members for burning, pitting, proper alignment, and discoloration caused by overheating; visual check of closing coils for deteriorated insulation and evidence of overheating or burning.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by pressing the E-Stop button.
 - 3) Operationally, the crane must be operated in the fine or float speed mode if a critical load is within 10 feet of any structure.
 - 4) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 5) During all critical lifts, there is at least one remote Emergency Stop (E-Stop) operator observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Relay, Aux Hoist (2 total)
Find Number: HCR RUN, LCR RUN (1 ea)
Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA		PMN/	K60-0528/
Part No:	NA	Name:	175-Ton Bridge Crane/VAB
Mfg/	Cutler Hammer/	Drawing/	67-K-L-11348/
Part No:	9575H2068A Model:6-2-3	Sheet No:	17

Function: Controls relay 2RUN for energizing the generator field winding during hoisting, lowering or float operations.

Critical Failure Mode/Failure Mode No:

- a. Coil fails open/
 - 09FY12-006.041 (HCR RUN)
 - 09FY12-006.044 (LCR RUN)
- b. N.O. contact fails open/
 - 09FY12-006.042 (HCR RUN)
 - 09FY12-006.045 (LCR RUN)
- c. N.C. contact fails closed/
 - 09FY12-006.043 (HCR RUN)
 - 09FY12-006.046 (LCR RUN)

Failure Cause:

- a. Corrosion, fatigue
- b. Corrosion, binding mechanism.
- c. Welded contacts, binding mechanism.

Failure Effect: (For all three failures) Relay 2RUN N.O. contact will not close and generator field winding will not be energized. No output from the generator. No hoist motor torque while the command is being given to raise, lower or float the load and the brakes are released. The load will descend with regenerative braking at 1.7 ft/min (0.34 in/sec) max (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be attempting to lift or float a forward assembly from the stop position,

releasing the brakes, the failure occurring, and the effect being the forward assembly descending and striking the VAB floor or platform, resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Contact Ratings</u>	<u>Actual</u>
600 volts	120 volts
10 amps	Testing required
<u>Coil Ratings</u>	<u>Actual</u>
120 volts	120 volts

- Contacts - Weld resistant, dome shaped, self wiping, silver cadmium oxide, double break operation.
- Coils - Bobbin wound coils are varnish impregnated under vacuum to prevent corrosion due to moisture.
- Armature - Balanced armature to minimize bounce for maximum contact life.
- Shock and vibration resistant construction.
- This relay was off-the-shelf hardware selected by the crane manufacturer for this application.

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.

Inspection:

- OMI Q6003, Maintenance Instructions, requires annual inspection of relay contacts and contact members for burning, pitting, proper alignment, and discoloration caused by overheating; visual check of closing coils for deteriorated insulation and evidence of overheating or burning.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by returning the Master Control Switch to neutral or pressing the E-Stop button (releasing the brake switch in the float mode).
 - 3) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 4) During all critical lifts, there is at least one Emergency Stop (E-Stop) operator remote from the operator's cab observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Relay, Aux Hoist
Find Number: 2XR
Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA		PMN/	K60-0528/
Part No:	NA	Name:	175-Ton Bridge Crane/VAB
Mfg/	General Electric/	Drawing/	67-K-L-11348/
Part No:	CR120AC4002AA	Sheet No:	17

Function: N.O. contacts close to energize the brake relays, 2BR and 2BR1, when the aux hoist controller is moved to release the brakes in normal operation.

Critical Failure Mode/Failure Mode No: N.O. contact fail closed/09FY12-006.047

Failure Cause: Welded contact, binding mechanism

Failure Effect: Brake relays will remain energized. Brakes will not set when auxiliary hoist motors are commanded, via the Master Control Switch to stop. The load will descend with regenerative braking at 1.7 ft/min (0.34 in/sec) max (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be attempting to bring a forward assembly to a stop while lowering, the failure occurring, and the effect being the forward assembly descending and striking the VAB floor or platform, resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Contact Ratings</u>	<u>Actual</u>
300 volts	120 volts
10 amps	Testing required

- Contact Material: Silver Cadmium Oxide, Self-cleaning
- Mechanical life expectancy is 10 million operations.
- This relay was off-the-shelf hardware selected by the crane manufacturer for this application.

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.

Inspection:

- OMI Q6003, Maintenance Instructions, requires annual inspection of contacts and contact members for burning, pitting, proper alignment, and discoloration caused by overheating; visual check of closing coils for deteriorated insulation and evidence of overheating or burning.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via the brake set light or Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by pressing the E-Stop button.
 - 3) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 4) During all critical lifts, there is at least one Emergency Stop (E-Stop) operator remote from the operator's cab observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Relay, Aux Hoist
Find Number: 2FW
Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA	NA	PMN/	K60-0528/
Part No:		Name:	175-Ton Bridge Crane/VAB
Mfg/	Westinghouse/	Drawing/	67-K-L-11348/
Part No:	cat. # 15825K2CNN, mech style # 453D263G02	Sheet No:	12, 13

Function: The relay energizes when power is applied to the crane, closing the three normally open (N.O.) contacts. The two series arranged contacts bypass resistor 2FWR to allow an increase in current to the DC motor field windings to strengthen the field. The third enables, but does not energize relay 2SRX.

The relay is deenergized while in the high speed mode, which opens the contacts, to place resistors 2FWR and RES A in series with the field windings to reduce the current and weaken the field.

Critical Failure Mode/Failure Mode No:

- a. Coil Fails Open/09FY12-006.106
- b. Contact Fails Open (1 of 3)/09FY12-006.107

Failure Cause:

- a. Corrosion, fatigue
- b. Corrosion, binding mechanism.

Failure Effect:

- a. The N.O. contacts will be opened placing resistors 2FWR and RES A in series with the DC motor field windings. The field will be weakened by the reduction of current through the windings. The hoist will be in the high speed mode configuration. The worst case scenario would be lowering a forward assembly in the coarse speed mode (maximum coarse speed is 25 ft/min), the failure occurring causing the hoist speed to increase to approximately three times the commanded speed, resulting in the forward assembly striking the VAB floor or platform resulting in possible damage to a vehicle system.
Time to effect: seconds.

- b. The N.O. contacts (1 of 3) will be opened placing resistor 2FWR or RES A in series with the DC motor field windings. The field will be weakened by the reduction of current through the windings. The hoist will descend at a higher rate of speed than expected (speed will be approximately double of the commanded input). The worst case scenario would be lowering a forward assembly in the coarse speed mode (maximum coarse speed is 25 ft/min), the failure occurring causing the hoist speed to increase to approximately two times the commanded speed, resulting in the forward assembly striking the VAB floor or platform resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Contact Ratings</u>	<u>Actual</u>
600 volts	183 volts
50 amps	14 amps
<u>Coil Ratings</u>	<u>Actual</u>
550 volt-amps	Testing required

- Contact material: silver.
- This relay was off-the-shelf hardware selected by the crane manufacturer for this application.

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems to be operated briefly in all speeds to verify satisfactory operation before lifting operations.

Inspection:

- OMI Q6003, Maintenance Instructions, requires annual inspection of contacts and contact members for burning, pitting, proper alignment, and discoloration caused by overheating; visual check of closing coils for deteriorated insulation and evidence of overheating or burning.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by pressing the E-Stop button.
 - 3) Operationally, the crane must be operated in the fine or float speed mode if a critical load is within 10 feet of any structure.
 - 4) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 5) During all critical lifts, there is at least one remote Emergency Stop (E-Stop) operator observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Foot Switch, Aux Hoist
Find Number: S2
Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA		PMN/	K60-0528/
Part No:	NA	Name:	175-Ton Bridge Crane/VAB
Mfg/		Drawing/	67-K-L-11348/
Part No:	Allen Bradley/ 805A-40	Sheet No:	17, 19

Function:

- Switch contact located between RPOT and the Generator Field DC Input Controller, arranged to disable the RPOT input when operating in the float mode.
- Contact closes to energize relay 2HCR to operate the crane in the float mode.
- Contact opens to enable the operator to control the brakes with brake switch S1 for float mode operations.

Critical Failure Mode/Failure Mode No:

- N.O. contact fails open/09FY12-006.054
- N.O. contact fails closed/09FY12-006.108
- N.C. contact fails closed/09FY12-006.109

Failure Cause:

- Corrosion, mechanical failure.
- Corrosion, welded contact, mechanical failure.
- Corrosion, welded contact, mechanical failure.

Failure Effect:

- No RPOT Generator Field DC Input Controller excitation voltage and the resulting output to the generator field winding. No output from generator. No hoist motor torque while the command is being given, via the Master Control Switch to raise or lower and the brakes are released. The load will descend with regenerative braking at 1.7 ft/min (0.34 in/sec) max (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be attempting to lift a forward assembly from the stop position, releasing the brakes, the failure occurring, and the effect being the forward

assembly descending and striking the VAB floor or platform, resulting in possible damage to a vehicle system. Time to effect: seconds.

- b. Relay 2HCR will remain energized. Brake relays 2BR & 2BR1 will remain energized and the brakes will be released while no command is being initiated to move the load. The load will descend with regenerative braking at 1.7 ft/min (0.34 in/sec) max (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be floating a forward assembly, releasing the foot switch to stop the float, the failure occurring, and the effect being the forward assembly descending and striking the VAB floor or platform, resulting in possible damage to a vehicle system. Time to effect: seconds.
- c. The brakes will be released when the foot switch is engaged. The load will descend with regenerative braking at 1.7 ft/min (0.34 in/sec) max (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be engaging the foot switch to begin float operations for a forward assembly, the failure occurring prior to the operator supplying an input to the generator field DC input controller from FPOT, and the effect being the forward assembly descending and striking the VAB floor or platform, resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Contact Ratings</u>	<u>Actual</u>
600 volts	120 volts

- Silver, double-break contacts.
- Internal parts enclosed for protection.
- This switch was off-the-shelf hardware selected by the crane manufacturer for this application.

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.
- OMI Q3008, Pre-Operation Setup Instructions, requires current limit checks prior to all major lifts of flight hardware (verifies motor, generator, generator field DC input controller, float control loop and DC power loop components are operational).

Inspection:

- OMI Q6003, Maintenance Instruction, requires annual inspection of switch contacts and contact members for burning, pitting, proper alignment, and discoloration caused by overheating. This item is not readily accessible for inspection.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by returning the Master Control Switch to neutral or pressing the E-Stop button.
 - 3) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 4) During all critical lifts, there is at least one Emergency Stop (E-Stop) operator remote from the operator's cab observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

KSC HAZARD REPORT printed 04/02/93 12:33:10 Contractor: LSOC page 1

HAZARD NUMBER: V-FAC-GEN-HR-08 DATE IDENTIFIED: 06/07/88
STATUS (O/C): C MASTER # K-POC-00000-P-CR TEAM: PGOC LOG # 44

TITLE: LOSS OF PERSONNEL/FLIGHT HARDWARE DURING LIFTING OPERATIONS

HAZARD DESCRIPTION:

Personnel injury or death and/or payload/equipment damage or loss due to dropping the load or collision with structure(s) during payload handling operations.

HAZARD CAUSE(S):

Use of improper/faulty equipment; failure of crane hook; failure of support equipment (slings, shackles, pins); improper rigging; improper operation of lifting equipment; failure of crane brake; load striking facility structures.

HAZARD EFFECT(S):

Personnel injury/death and/or damage to facility, payload, and GSE.

ENGINEERING/SAFETY REQUIREMENTS:

NSS/GO 1740.9 - NASA Safety Standard for Lifting Devices and Equipment.

ELIMINATION/CONTROL/ACCEPTED RISK RATIONALE:

Requirements for inspection, maintenance, proof testing, and certification of cranes and lifting equipment shall be in accordance with NSS/GO 1740.9, "NASA Safety Standard for Lifting Devices and Equipment."

A proofload test at 1.25 times the rated load and an operational test shall be performed on all new or extensively repaired, extensively modified, or altered cranes and hoists.

Each crane shall undergo a rated load test and an operational test every four years. Critical cranes shall be load tested annually. Cranes used infrequently for critical lifts shall be load tested before the critical lift if it has been more than a year since the last test.

Daily and periodic inspections will be performed for all cranes. Cranes idle for more than one month shall be inspected prior to first use in accordance with NSS/GO-1740.9.

Daily inspections include: a check of functional operating and control mechanisms for maladjustments, excessive wear and contamination; a visual inspection of fluid system components for deterioration and leaks; and a visual inspection of the crane components (e.g., hook, ropes, etc.) for damage or excessive wear.

Periodic inspections per NSS/GO-1740.9 include inspections for: worn, cracked, deformed, corroded, or contaminated crane components (use of nondestructive evaluation to be utilized as needed or required by NSS/GO-1740.9); worn brake and clutch system components; and abnormal performance/malfunction of power plant(s), safety devices, load/other indicators, brakes, steering, and locking devices.

ACCEPTANCE RATIONALE

Design:

<u>Contact Ratings</u>	<u>Actual</u>
600 volts	109 volts max
150 amps	Testing required
<u>Coil Ratings</u>	<u>Actual</u>
600 volts	120 volts

- Contact material: silver.
- Coil can withstand 110% of rated voltage without burnout.
- This relay was off-the-shelf hardware selected by the crane manufacturer for this application.

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.

Inspection:

- OMI Q6003, Maintenance Instructions, requires annual inspection of relay contacts and contact members for burning, pitting, proper alignment, and discoloration caused by overheating; visual check of closing coils for deteriorated insulation and evidence of overheating or burning.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by returning the Master Control Switch to neutral or pressing the E-Stop button.
 - 3) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 4) During all critical lifts, there is at least one Emergency Stop (E-Stop) operator remote from the operator's cab observing the load lift, and can stop the crane if a failure indication is noticed.

- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Potentiometer, Aux Hoist
Find Number: RPOT
Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA		PMN/	K60-0528/
Part No:	NA	Name:	175-Ton Bridge Crane/VAB
Mfg/	Ohmite/	Drawing/	67-K-L-11348/
Part No:	RHS750	Sheet No:	19

Function: Reference potentiometer connected to the master control switch, 2MC, (joystick) to control the input excitation voltage to the generator field DC input controller, 2FC, and the resulting output to the generator field winding for aux hoist speed control during raising or lowering operations.

Critical Failure Mode/Failure Mode No: Fail open/09FY12-006.053

Failure Cause: Corrosion, fatigue

Failure Effect: If the failure occurs on the wiper arm it would result in no generator field DC input controller excitation voltage and the resulting output to the generator field winding. No output from generator. No hoist motor torque while the command is being given, via the Master Control Switch to raise or lower and the brakes are released. The load will descend with regenerative braking at 1.7 ft/min (0.34 in/sec) max (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be attempting to lift a forward assembly from the stop position, releasing the brakes, the failure occurring, and the effect being the forward assembly descending and striking the VAB floor or platform, resulting in possible damage to a vehicle system. Time to effect: seconds.

OR

If the failure occurs on the resistive element, it would result in a loss of the parallel resistance branch which will create a larger input into the generator field DC input controller which will cause an increasing speed of the DC motors controlling the aux hoist. The worst case would be attempting to lower a forward assembly while in the coarse mode of operation, the failure occurring, causing a sudden increase to full coarse speed and the effect being the forward assembly striking the VAB floor or platform, resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Rated Power</u>	<u>Actual Power</u>
25 watts	.18 watts
<u>Rated Voltage</u>	<u>Actual Voltage</u>
300 volts	12 volts
<u>Rated Current</u>	<u>Actual Current</u>
.176 amps	.015 amps

- Material:
 - Body: Ceramic
 - Windings: High grade resistance alloy
 - Coating: Vitreous enamel
 - Contact Arm: Metal graphite composition
 - Terminals: Solder coated
- Resistance tolerance: +/- 10 %

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.
- OMI Q3008, Pre-Operation Setup Instructions, requires current limit checks prior to all major lifts of flight hardware (verifies motor, generator, generator field DC input controller, float control loop and DC power loop components are operational).

Inspection:

- This item is not readily accessible for inspection. OMI Q6003, Maintenance Instructions, instructs that inspections shall not entail disassembly of equipment.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by returning the Master Control Switch to neutral or pressing the E-Stop button.
 - 3) If the speed increase failure occurs in the fine speed mode of operation, the motor generator set will be shut down by an overvoltage protection relay when the voltage in the DC motor loop reaches 115% of full fine voltage.
 - 4) Operationally, the crane must be operated in the fine speed mode if a critical load is within 10 feet of any structure.
 - 5) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 6) During all critical lifts, there is at least one remote Emergency Stop (E-Stop) operator observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

Critical Item: Resistor, Auxiliary Hoist (2 total)

Find Number: 2RR4A, 2RR4B (1ea)

Criticality Category: 2

SAA No: 09FY12-006

System/Area: 175-Ton Bridge Crane/VAB

NASA

PMN/ K60-0528/

Part No: NA

Name: 175-Ton Bridge Crane/VAB

Mfg/ DIGI-KEY/

Drawing/ 67-K-L-11348/

Part No: P 1.6KW-2

Sheet No: 19

Function: Provides a voltage divider for the +/- 6VDC power source to the potentiometer, R-POT, in the master controller (joystick), 2MC, for input to the generator field DC input controller, 2FC, to allow for auxiliary hoist operation in the fine speed mode.

Critical Failure Mode/Failure Mode No: Fails open/09FY12-006.078

Failure Cause: Contamination, corrosion, fatigue

Failure Effect: No generator field DC input controller excitation voltage in the fine speed mode of operation. No generator field winding voltage. No output from the generator. No hoist motor torque when the command is given, via the master control switch to raise or lower the load while the brakes are released. The load will descend with regenerative braking at 1.7 ft/min (0.34 in/sec) max (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be attempting to lift a forward assembly from the stop position, releasing the brakes, the failure occurring, and the effect being the forward assembly descending and striking the VAB floor or platform, resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

- 1600 Ohm Resistor
- 5% Metal Oxide Film Resistor
- Resistance tolerance: +/- 5%.
- Meets overload tests in accordance with UL (Underwriters Laboratories) specification #1412 without producing a fire hazard.
- Withstands solvents in accordance with Mil-Std-202E without producing mechanical or electrical damage.

- Temperature coefficient: +/- 100 PPM/°C typ., +/- 200 PPM/°C max.
- Maximum working voltage: 350 volts
- Actual working voltage: 6 volts
- Rated power: 2 watts
- Actual power: 0.0082 watts

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.

Inspection:

- OMI Q6003, Maintenance Instructions, requires annual inspection of resistors for deterioration/discoloration caused by corrosion or overheating.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- **Correcting Action:**
 - 1) The failures can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by returning the master control switch to neutral, or pressing the E-Stop button.
 - 3) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 4) During all critical lifts, there is at least one remote Emergency Stop (E-Stop) operator observing the load lift, and can stop the crane if a failure indication is noticed.
- **Timeframe:**
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Potentiometer, Aux Hoist
Find Number: FPOT
Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA		PMN/	K60-0528/
Part No:	NA	Name:	175-Ton Bridge Crane/VAB
Mfg/	Ohmite/	Drawing/	67-K-L-11348/
Part No:	RHS750	Sheet No:	19

Function: Controls the input excitation voltage to the generator field DC input controller, 2FC, and the resulting output to the generator field winding for aux hoist control during float operations.

Critical Failure Mode/Failure Mode No: Fail open/09FY12-006.056

Failure Cause: Corrosion, fatigue

Failure Effect: If the failure occurs on the wiper arm it would result in no generator field DC input controller excitation voltage and the resulting output to the generator field winding. No output from generator. No hoist motor torque while the command is being given to float and the brakes are released. The load will descend with regenerative braking at 1.7 ft/min (0.34 in/sec) max (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be attempting to float a forward assembly from the stop position, releasing the brakes, the failure occurring, and the effect being the forward assembly descending and striking the VAB floor or platform, resulting in possible damage to a vehicle system. Time to effect: seconds.

OR

If the failure occurs on the resistive element, it would result in a loss of the parallel resistance branch which will create a larger input into the generator field DC input controller which will cause an increasing input to the DC motors controlling the aux hoist. The worst case would be floating a forward assembly (near zero vertical speed), the failure occurring, causing an inadvertent movement of the load and the effect being the forward assembly descending and striking the VAB floor or platform, resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Rated Power</u>	<u>Actual Power</u>
25 watts	.18 watts
<u>Rated Voltage</u>	<u>Actual Voltage</u>
300 volts	12 volts
<u>Rated Current</u>	<u>Actual Current</u>
.176 amps	.015 amps

- Material:
 - Body: Ceramic
 - Windings: High grade resistance alloy
 - Coating: Vitreous enamel
 - Contact Arm: Metal graphite composition
 - Terminals: Solder coated
- Resistance tolerance: +/- 10 %

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.
- OMI Q3008, Pre-Operation Setup Instructions, requires current limit checks prior to all major lifts of flight hardware (verifies motor, generator, generator field DC input controller, float control loop and DC power loop components are operational).

Inspection:

- This item is not readily accessible for inspection. OMI Q6003, Maintenance Instructions, instructs that inspections shall not entail disassembly of equipment.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by releasing the brake switch or pressing the E-Stop button.
 - 3) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 4) During all critical lifts, there is at least one Emergency Stop (E-Stop) operator remote from the operator's cab observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Resistor, Auxiliary Hoist

Find Number: 2RR7

Criticality Category: 2

SAA No: 09FY12-006

System/Area: 175-Ton Bridge Crane/VAB

NASA

PMN/ K60-0528/

Part No: NA

Name: 175-Ton Bridge Crane/VAB

Mfg/ DIGI-KEY/

Drawing/ 67-K-L-11348/

Part No: P 56KW-2

Sheet No: 19

Function: Provides a voltage divider for the input from the float potentiometer, F POT, to the generator field DC input controller, 2FC, to allow for auxiliary hoist operation in the float mode.

Critical Failure Mode/Failure Mode No: Fails open/09FY12-006.079

Failure Cause: Contamination, corrosion, fatigue

Failure Effect: No generator field DC input controller excitation voltage in the float mode of operation. No generator field winding voltage. No output from the generator. No hoist motor torque when the command is given to float the load while the brakes are released, via the brake switch. The load will descend with regenerative braking at 1.7 ft/min (0.34 in/sec) max (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be floating the forward assembly (near zero vertical speed), releasing the brakes, the failure occurring, and the effect being the forward assembly descending and striking the VAB floor or platform, resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

- 56000 Ohm Resistor
- 5% Metal Oxide Film Resistor
- Resistance tolerance: +/- 5%.
- Meets overload tests in accordance with UL (Underwriters Laboratories) specification #1412 without producing a fire hazard.
- Withstands solvents in accordance with Mil-Std-202E without producing mechanical or electrical damage.

- Temperature coefficient: +/- 100 PPM/°C typ., +/- 200 PPM/°C max.
- Maximum working voltage: 350 volts
- Actual working voltage: 6 volts
- Rated power: 2 watts
- Actual power: 0.00064 watts

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.
- OMI Q3008, Pre-Operation Setup Instructions, requires current limit checks prior to all major lifts of flight hardware (verifies motor, generator, generator field DC input controller, float control loop and DC power loop components are operational).

Inspection:

- OMI Q6003, Maintenance Instructions, requires annual inspection of resistors for deterioration/discoloration caused by corrosion or overheating.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failures can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by releasing the brake switch, or pressing the E-Stop button.
 - 3) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 4) During all critical lifts, there is at least one remote Emergency Stop (E-Stop) operator observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Meter Relay, Auxiliary Hoist

Find Number: M2

Criticality Category: 2

SAA No: 09FY12-006

System/Area: 175-Ton Bridge Crane/VAB

NASA

PMN/ K60-0528/

Part No: NA

Name: 175-Ton Bridge Crane/VAB

Mfg/ Larson Instrument Co./

Drawing/ 67-K-L-11348/

Part No: CMC 3.5 K-L

Sheet No: 19

Function: Controls relay K9 to scale current reading on console ammeter by a factor of 10 when the hoist motors current reaches 20 amps. Also controls indicator light to indicate to operator when current reading is scaled.

Critical Failure Mode/Failure Mode No:

High/Low Limit No. 2 N.C. contact fails open/09FY12-006.060

Failure Cause: Corrosion, binding mechanism

Failure Effect: Relay K9 will not be energized and the current reading on the console ammeter will be scaled without indication from console light PL34. This could lead to an operator giving an erroneous input during float operations resulting in inadvertent movement of load. Possible damage to vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Rating</u>	<u>Actual</u>
115 volts	120 volts

- This relay was off-the-shelf hardware selected by the crane manufacturer for this application.

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMRSD file VI requires verification of proper performance of console ammeter switch-over point (main hoist-60A, aux hoist-20A) annually.

- OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.

Inspection:

- This is a self-contained unit with contacts that are not readily accessible for inspection. OMI Q6003, Maintenance Instructions, instructs that inspections shall not entail disassembly of equipment.

Failure History:

- The PRACA database was researched and failure data was found on this component in the critical failure mode.
 - The failures occurred on 7/23/91, 8/14/91, and 10/3/91.
 - The failure cause was binding mechanism.
 - The correcting action was remove and replace the relay.

NOTE: These failures did not necessarily occur on this crane drive system. The failure may have occurred on either the main or auxiliary hoist drive systems of this crane or one of the two VAB 250-Ton Bridge Cranes.

- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via a Selsyn (inadvertent movement) that is in view of both operators.
 - 2) Operator can stop all crane operations, when the failure indication is noticed, by returning the master control switch to neutral, by releasing the brake switch or pressing the E-Stop button.
 - 3) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 4) During all critical lifts, there is at least one Emergency Stop (E-Stop) operator remote from the operator's cab observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Relay, Auxiliary Hoist

Find Number: K9

Criticality Category: 2

SAA No: 09FY12-006

System/Area: 175-Ton Bridge Crane/VAB

NASA

PMN/ K60-0528/

Part No: NA

Name: 175-Ton Bridge Crane/VAB

Mfg/ Potter-Brumfield/

Drawing/ 67-K-L-11348/

Part No: KHP 17411

Sheet No: 19

Function: Energized when hoist motors are drawing less than 20 amps. Contacts are closed to allow the console ammeter to display actual current. De-energized and contacts opened when current reaches 20 amps to scale the current reading on the console ammeter by a factor of 10.

Critical Failure Mode/Failure Mode No:

- a. Coil fails open/09FY12-006.061
- b. N.O. contact fail open/09FY12-006.062

Failure Cause:

- a. Corrosion, fatigue
- b. Corrosion, binding mechanism

Failure Effect: (For both failures) The current reading on the console ammeter will be scaled without indication from console light PL34. This could lead to an operator giving an erroneous input during float operations resulting in an inadvertent movement of the load. Possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

- Coil Rating: 240 volts
- Coil Actual: 120 volts
- Contact material: Silver
- Expected mechanical life of 10 million operations.

- This relay was off-the-shelf hardware selected by the crane manufacturer for this application.

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMRSD file VI requires verification of proper performance of console ammeter switch-over point (main hoist-60A, aux hoist-20A) annually.
- OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.

Inspection:

- OMI Q6003, Maintenance Instructions requires annual inspection of relay contacts and contact members for burning, pitting, proper alignment and discoloration caused by overheating. Visually check closing coils for deteriorated insulation and evidence of overheating or burning.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via a Selsyn (inadvertent movement) that is in view of both operators.
 - 2) Operator can stop all crane operations, when the failure indication is noticed, by returning the master control switch to neutral, by releasing the brake switch or pressing the E-Stop button.
 - 3) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 4) During all critical lifts, there is at least one Emergency Stop (E-Stop) operator remote from the operator's cab observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Relay, Aux Hoist
Find Number: 2VR
Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA		PMN/	K60-0528/
Part No:	NA	Name:	175-Ton Bridge Crane/VAB
Mfg/	General Electric/	Drawing/	67-K-L-11348/
Part No:	1C2820A100 AB2E	Sheet No:	17, 19

Function: Monitors voltage in the aux hoist motor loop and provides latching to keep relays 2HCR or 2LCR energized after master control switch, 2MC, is returned to neutral position. This prevents the brakes from setting while voltage in the motor loop is above a predetermined limit.

Critical Failure Mode/Failure Mode No: N.O. contact fail closed/09FY12-006.064

Failure Cause: Welded contact, binding mechanism.

Failure Effect: Brake relays will remain energized and the brakes will not set when main hoist motors are commanded to stop via the Master Control Switch. The load will descend with regenerative braking at 1.7 ft/min (0.34 in/sec) max (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be attempting to bring a forward assembly to a stop while hoisting or lowering, the failure occurring, and the effect being the forward assembly descending and striking the VAB floor or platform, resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Ratings</u>	<u>Actual</u>
600 volts	120 volts
10 amps	Testing required

- Contact Material: Silver Cadmium Oxide, Self-cleaning.
- This relay was off-the-shelf hardware selected by the crane manufacturer for this application.

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.

Inspection:

- OMI Q6003, Maintenance Instructions. requires annual inspection of contacts and contact members for burning, pitting, proper alignment, and discoloration caused by overheating; visual check of closing coils for deteriorated insulation and evidence of overheating or burning.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by pressing the E-Stop button.
 - 3) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 4) During all critical lifts, there is at least one Emergency Stop (E-Stop) operator remote from the operator's cab observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Relay, Aux Hoist

Find Number: 2KR

Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA	NA	PMN/	K60-0528/
Part No:		Name:	175-Ton Bridge Crane/VAB
Mfg/	General Electric/	Drawing/	67-K-L-11348/
Part No:	CR105CO, NEMA Size 1	Sheet No:	18, 19

Function: The relay energizes when power is applied to the hoist motor-generator set closing the normally open (N.O.) contact to energize relay 2SRX. Relay 2SRX contact closes to bypass resistor RES A which allows an increase in current to the DC motor field windings to strengthen the field for normal operations.

Critical Failure Mode/Failure Mode No: N.O. Contact Fails Open/09FY12-006.110

Failure Cause: Corrosion, binding mechanism

Failure Effect: The N.O. contact will be open to deenergize relay 2SRX. This places resistor RES A in series with the DC motor field windings. The field will be weakened by the reduction of current through the windings. The hoist will descend at a higher rate of speed than expected (speed will be approximately double of the commanded input). The worst case scenario would be lowering a forward assembly in the coarse speed mode (maximum coarse speed is 25 ft/min), the failure occurring causing the hoist speed to increase to approximately two times the commanded speed, resulting in the forward assembly striking the VAB floor or platform resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Contact Ratings</u>	<u>Actual</u>
600 volts	183 volts
30 amps	Testing required

- Contact Material: Silver Cadmium Oxide.
- This relay was off-the-shelf hardware selected by the crane manufacturer for this application.

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems to be operated briefly in all speeds to verify satisfactory operation before lifting operations.

Inspection:

- OMI Q6003, Maintenance Instructions, requires annual inspection of contacts and contact members for burning, pitting, proper alignment, and discoloration caused by overheating; visual check of closing coils for deteriorated insulation and evidence of overheating or burning.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by pressing the E-Stop button.
 - 3) Operationally, the crane must be operated in the fine or float speed mode if a critical load is within 10 feet of any structure.
 - 4) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 5) During all critical lifts, there is at least one remote Emergency Stop (E-Stop) operator observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Relay, Aux Hoist
Find Number: 2SRX
Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA	NA	PMN/	K60-0528/
Part No:		Name:	175-Ton Bridge Crane/VAB
Mfg/	General Electric/	Drawing/	67-K-L-11348/
Part No:	IC28001607F2	Sheet No:	18

Function: The relay energizes when power is applied to the hoist motor-generator set, closing the normally open (N.O.) contact to allow an increase in current to the DC motor field windings to strengthen the field for normal operations.

The relay is deenergized while in the high speed mode, which opens the contacts, to place resistor RES A in series with the field windings to reduce the current and weaken the field.

Critical Failure Mode/Failure Mode No:

- a. Coil Fails Open/09FY12-006.111
- b. Contact Fails Open/09FY12-006.112

Failure Cause:

- a. Corrosion, fatigue
- b. Corrosion, binding mechanism

Failure Effect: (For both failures) The N.O. contact will be opened placing resistor RES A in series with the DC motor field windings. The field will be weakened by the reduction of current through the windings. The hoist will descend at a higher rate of speed than expected (speed will be approximately double of the commanded input). The worst case scenario would be lowering a forward assembly in the coarse speed mode (maximum coarse speed is 25 ft/min), the failure occurring causing the hoist speed to increase to approximately two times the commanded speed, resulting in the forward assembly striking the VAB floor or platform resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Contact Ratings</u>	<u>Actual</u>
600 volts	183 volts
25 amps	14 amps

- This relay was off-the-shelf hardware selected by the crane manufacturer for this application.

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems to be operated briefly in all speeds to verify satisfactory operation before lifting operations.

Inspection:

- OMI Q6003, Maintenance Instructions, requires annual inspection of contacts and contact members for burning, pitting, proper alignment, and discoloration caused by overheating; visual check of closing coils for deteriorated insulation and evidence of overheating or burning.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by pressing the E-Stop button.
 - 3) Operationally, the crane must be operated in the fine or float speed mode if a critical load is within 10 feet of any structure.
 - 4) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 5) During all critical lifts, there is at least one remote Emergency Stop (E-Stop) operator observing the load lift, and can stop the crane if a failure indication is noticed.

- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Generator Field DC Input Controller, Auxiliary Hoist
Find Number: 2FC
Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA		PMN/	K60-0528/
Part No:	NA	Name:	175-Ton Bridge Crane/VAB
Mfg/	Reflex/	Drawing/	67-K-L-11348/
Part No:	URRK-VIII	Sheet No:	19

Function: A solid state assembly which provides DC excitation to the generator field of the motor-generator set (M9-G3). The excitation is proportional to the input supplied from the control potentiometers (R POT, F POT) and is used to drive the DC motors which control the auxiliary hoist.

Critical Failure Mode/Failure Mode No:

- a. No output/09FY12-006.084
- b. High output (not inverted)/09FY12-006.085
- c. High output (inverted)/09FY12-006.086

Failure Cause:

- a. Contamination, corrosion, board component open.
- b. Board component short, board component open, loss of voltage feedback from the DC drive motor loop.
- c. Board component short.

Failure Effect:

- a. No DC excitation voltage to the generator field winding. No output from the generator. No hoist motor torque when the command is given to raise, lower, or float the load while the brakes are released. The load will descend with regenerative braking at 1.7 ft/min (0.34 in/sec) max (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be attempting to lift the forward assembly from the stop position, releasing the brakes, the failure occurring, and the effect being the forward assembly descending and striking the VAB floor or platform, resulting in possible damage to a vehicle system. Time to effect: seconds.
- b. Increasing speed of the DC motors controlling the aux hoist. The worst case would be attempting to lower the forward assembly in the slow coarse mode of operation, the

failure occurring causing a sudden increase to full coarse speed resulting in the the forward assembly striking the VAB floor or platform at a velocity of 25 ft/min causing possible damage to a vehicle system. Time to effect: seconds.

- c. Increasing speed, in the opposite direction than commanded, of the DC motors controlling the aux hoist. The worst case would be attempting to lift the forward assembly in the slow coarse mode of operation, the failure occurring causing a sudden increase to full coarse speed downward resulting in the the forward assembly striking the VAB floor or platform at a velocity of 25 ft/min causing possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

- Voltage feedback from the DC motor armature loop maintains a constant output to the drive motors at $\pm 2\%$. This prevents an overvoltage condition from driving the crane faster than is commanded by the operator.
- Current feedback from the DC motor armature loop prevents the crane from being driven faster than is allowable in maximum coarse speed.
- Current feedback from the generator field winding maintains the proper gating for output to the generator field.
- Output can be regulated and will remain constant each time the crane is being used. This allows for uniformity in expected crane reactions to inputs from the operator.
- Output to the generator field is supplied up to positive or negative 109 volts in response to an input of positive or negative 6 volts.
- Rated power: 4K watts
- Actual power: 2K watts
- Rated temperature: 0 to 50° C.
- Actual temperature: Ambient.

Test:

- a. OMRSD file VI requires verification of proper performance of hoist operational test annually.
- b. OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.
- c. OMI Q3008, Pre-Operation Setup Instructions, requires current limit checks prior to all major lifts of flight hardware (verifies motor, generator, generator field DC input controller, float control loop and DC power loop components are operational).
- d. OMI Q3008, Pre-Operation Setup Instructions, requires a verification of proper operation of the overvoltage protection relays prior to all critical lifts.

Inspection:

- OMI Q6003, Maintenance Instructions, will require an annual visual inspection of the solid state circuit board assemblies for evidence of burning, discoloration caused by over-heating, contamination or corrosion.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by returning the Master Control Switch to neutral or pressing the E-Stop button (releasing the brake switch in float mode).
 - 3) When the high output failure occurs in the fine speed or float mode, the motor generator set will be shut down by an overvoltage protection relay when the voltage in the DC motor loop reaches 115% of full float voltage in the float mode, or 115% of full fine voltage in the fine mode (see Test item d for operational verification information).
 - 4) Operationally, the crane must be operated in the fine or float speed mode if a critical load is within 10 feet of any structure.
 - 5) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 6) During all critical lifts, there is at least one remote Emergency Stop (E-Stop) operator observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Relay, Auxiliary Hoist
Find Number: 2XR1
Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA		PMN/	K60-0528/
Part No:	NA	Name:	175-Ton Bridge Crane/VAB
Mfg/	Allen Bradley/	Drawing/	67-K-L-11348/
Part No:	700-P400A1	Sheet No:	17, 19

Function: Enables the generator field DC input controller, 2FC, when relay 2HCR or 2LCR is energized.

Critical Failure Mode/Failure Mode No:

- a. Coil fails open/09FY12-006.080
- b. N.O. contact fails open/09FY12-006.081
- c. N.O. contact fails open/09FY12-006.082
- d. N.O. contact fails open/09FY12-006.083

Failure Cause:

- a. Corrosion, fatigue
- b. Corrosion, binding mechanism
- c. Corrosion, binding mechanism
- d. Corrosion, binding mechanism

Failure Effect:

- a. The contacts will remain deenergized. No DC excitation voltage to the generator field winding. No output from the generator. No hoist motor torque when the command is given to raise, lower, or float the load while the brakes are released. The load will descend with regenerative braking at 1.7 ft/min (0.34 in/sec) (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be attempting to lift an SRB forward assembly from the stop position, releasing the brakes, the failure occurring, and the effect being the forward assembly descending striking the VAB floor or platform, resulting in possible damage to a vehicle system. Time to effect: seconds.

- b. The speed regulator in the generator field DC input controller will not be enabled. No DC excitation voltage to the generator field winding. No output from the generator. No hoist motor torque when the command is given to raise, lower, or float the load while the brakes are released. The load will descend with regenerative braking at 1.7 ft/min (0.34 in/sec) (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be attempting to lift an SRB forward assembly from the stop position, releasing the brakes, the failure occurring, and the effect being the forward assembly descending striking the VAB floor or platform, resulting in possible damage to a vehicle system. Time to effect: seconds.
- c. The bi-directional amplifier in the generator field DC input controller will not be enabled. No DC excitation voltage to the generator field winding. No output from the generator. No hoist motor torque when the command is given to raise, lower, or float the load while the brakes are released. The load will descend with regenerative braking at 1.7 ft/min (0.34 in/sec) (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be attempting to lift an SRB forward assembly from the stop position, releasing the brakes, the failure occurring, and the effect being the forward assembly descending striking the VAB floor or platform, resulting in possible damage to a vehicle system. Time to effect: seconds.
- d. The firing circuit in the generator field DC input controller will not be enabled. No DC excitation voltage to the generator field winding. No output from the generator. No hoist motor torque when the command is given to raise, lower, or float the load while the brakes are released. The load will descend with regenerative braking at 1.7 ft/min (0.34 in/sec) (based on maximum load capacity of the hoist, in reality this would descend slower). The worst case would be attempting to lift an SRB forward assembly from the stop position, releasing the brakes, the failure occurring, and the effect being the forward assembly descending striking the VAB floor or platform, resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

- Contact Voltage Rating: 600 VDC
- Contact Voltage Actual: 15 VDC
- Contact Material: Nickel Silver (Ni Ag)
- Coil Voltage Rating: 600 VAC
- Coil Voltage Actual: 120 VAC
- Coil Power Rating: 20 VA 60 Hz (sealed), 138 VA 60 Hz (inrush)
- Pickup Time: 20 msec
- Dropout Time: 20 msec
- Rated Operating Temperature: -20°C to +40°C
- Actual Operating Temperature: Ambient
- UL (Underwriters Laboratory) listed

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.
- OMI Q3008, Pre-Operation Setup Instructions, requires current limit checks prior to all major lifts of flight hardware (verifies motor, generator, generator field DC input controller, float control loop and DC power loop components are operational).

Inspection:

- OMI Q6003, Maintenance Instructions, requires annual inspection of contacts and contact members for burning, pitting, proper alignment, and discoloration caused by overheating; visual check of closing coils for deteriorated insulation and evidence of overheating or burning.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by returning the Master Control Switch to neutral or pressing the E-Stop button (releasing the brake switch in the float mode).
 - 3) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 4) During all critical lifts, there is at least one remote Emergency Stop (E-Stop) operator observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Synchro Transmitter and Receiver Assembly, Aux Hoist
Find Number: 2SYNT/2SYNR2
Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA		PMN/	K60-0528/
Part No:	NA	Name:	175-Ton Bridge Crane/VAB
Mfg/	General Electric/	Drawing/	67-K-L-11348/
Part No:	2JDA66PA10A, 5PY-5GTY23	Sheet No:	20

Function: Provides aux hoist position and motion indication to the operator in the cab. The operator uses this indicator to determine movement distance when required to make small incremental moves for mate/demate operations.

Critical Failure Mode/Failure Mode No: Erroneous Output (indication)/09FY12-006.113

Failure Cause: Corrosion, binding mechanism

Failure Effect: Loss of accurate position indication or load motion indication could result in improper load positioning. The worst case would be attempting to mate or demate a forward assembly from the work platform, the failure occurring, and the effect being the operator commanding too much movement and the forward assembly contacting the platform. Possible damage to vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Ratings</u>	<u>Actual</u>
115 volts	120 volts

- Totally enclosed nonventilated cast housing.
- Motor-type rotor is the only moving part.
- This item was off-the-shelf hardware selected by the crane manufacturer for this application.

Test:

- OMRSD file VI requires verification of proper performance of hoist operational test annually.

- OMI Q3008, Operating Instructions, requires all crane systems to be operated briefly in all speeds to verify satisfactory operation before lifting operations.

Inspection:

- OMI Q6003, Maintenance Instructions, require monthly inspection for quietness and smoothness during operation; monthly inspection of belt drives for worn, frayed or abnormal wear; monthly inspection for broken, bent or badly worn pulleys; monthly verification by examination and manipulation that keys and couplings are securely in place; annual removal and inspection of brushes and replacement of brushes when overall length is 3/8-inch or less.

Failure History:

- The PRACA database was researched and failure data was found on this component in the critical failure mode.
 - The failures occurred on 3/9/91, 10/10/91, and 10/8/92.
 - The failure cause was binding mechanism.
 - The correcting action was to remove and replace the selsyn receiver (3/9/91), or to remove, repair and replace the selsyn receiver (10/10/91 & 10/8/92).

NOTE: These failures did not necessarily occur on this crane drive system. The failure may have occurred on any one of the drive systems of this crane or one of the two VAB 250-Ton Bridge Cranes.

- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) When the failure indication is noticed, the operator can stop all crane operations by returning the Master Control Switch to neutral or pressing the E-Stop button (releasing the brake switch in the float mode).
 - 2) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 3) During all critical lifts, there is at least one remote Emergency Stop (E-Stop) operator observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Potentiometer, Bridge

Find Number: RPOT

Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA		PMN/	K60-0528/
Part No:	NA	Name:	175-Ton Bridge Crane/VAB
Mfg/	Ohmite/	Drawing/	67-K-L-11348/
Part No:	RHS750	Sheet No:	24

Function: Reference potentiometer connected to the master control switch, 3MC, (joystick) to control the input excitation voltage to the generator field DC input controller, 3FC, and the resulting output to the generator field winding for bridge speed control during operations.

Critical Failure Mode/Failure Mode No: Fail open/09FY12-006.115

Failure Cause: Corrosion, fatigue

Failure Effect: If the failure occurs on the resistive element, it would result in a loss of the parallel resistance branch which will create a larger input into the generator field DC input controller which will cause an increasing speed of the DC motors controlling the bridge. The worst case would be attempting to move an External Tank (ET) or the aft end of the orbiter while in the coarse mode of operation, the failure occurring, causing a sudden increase to full coarse speed and the effect being the ET or the aft end of the orbiter striking the VAB wall or platform, resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Rated Power</u>	<u>Actual Power</u>
25 watts	.18 watts
<u>Rated Voltage</u>	<u>Actual Voltage</u>
300 volts	12 volts
<u>Rated Current</u>	<u>Actual Current</u>
.176 amps	.015 amps

- Material:
 - Body: Ceramic
 - Windings: High grade resistance alloy
 - Coating: Vitreous enamel
 - Contact Arm: Metal graphite composition
 - Terminals: Solder coated
- Resistance tolerance: +/- 10 %

Test:

- OMRSD file VI requires verification of proper performance of the bridge operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.
- OMI Q3008, Pre-Operation Setup Instructions, requires current limit checks prior to all major lifts of flight hardware (verifies motor, generator, generator field DC input controller, float control loop and DC power loop components are operational).

Inspection:

- This item is not readily accessible for inspection. OMI Q6003, Maintenance Instructions, instructs that inspections shall not entail disassembly of equipment.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by returning the Master Control Switch to neutral or pressing the E-Stop button.
 - 3) If the speed increase failure occurs in the fine speed mode of operation, the motor generator set will be shut down by an overvoltage protection relay when the voltage in the DC motor loop reaches 115% of full fine voltage.
 - 4) Operationally, the crane must be operated in the fine speed mode if a critical load is within 10 feet of any structure.
 - 5) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.

- 6) During all critical lifts, there is at least one remote Emergency Stop (E-Stop) operator observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Generator Field DC Input Controller, Bridge

Find Number: 3FC

Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA		PMN/	K60-0528/
Part No:	NA	Name:	175-Ton Bridge Crane/VAB
Mfg/	Reflex/	Drawing/	67-K-L-11348/
Part No:	URRK-VIII	Sheet No:	24

Function: A solid state assembly which provides DC excitation to the generator field of the motor-generator set (M1-G1). The excitation is proportional to the input supplied from the control potentiometer (R POT) and is used to drive the DC motors which control the bridge.

Critical Failure Mode/Failure Mode No:

- a. High output (not inverted)/09FY12-006.074
- b. High output (inverted)/09FY12-006.075

Failure Cause:

- a. Board component short, board component open, loss of voltage feedback from the DC drive motor loop.
- b. Board component short.

Failure Effect:

- a. Increasing speed of the DC motors controlling the bridge. The worst case would be attempting to move the orbiter to the north in the slow coarse mode of operation, while suspended above the VAB transfer aisle, the failure occurring causing a sudden increase to full coarse speed resulting in the orbiter sling striking the tail of the orbiter at a velocity of 75 ft/min, causing possible damage to a vehicle system. Time to effect: seconds.
- b. Increasing speed, in the opposite direction than commanded, of the DC motors controlling the bridge. The worst case would be attempting to move the orbiter to the south in the slow coarse mode of operation, while suspended above the VAB transfer aisle, the failure occurring causing a sudden increase to full coarse speed to the north resulting in the orbiter sling striking the tail of the orbiter at a velocity of 75 ft/min, causing possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

- Voltage feedback from the DC motor armature loop maintains a constant output to the drive motors at $\pm 2\%$. This prevents an overvoltage condition from driving the crane faster than is commanded by the operator.
- Current feedback from the DC motor armature loop prevents the crane from being driven faster than is allowable in maximum coarse speed.
- Current feedback from the generator field winding maintains the proper gating for output to the generator field.
- Output can be regulated and will remain constant each time the crane is being used. This allows for uniformity in expected crane reactions to inputs from the operator.
- Output to the generator field is supplied up to positive or negative 109 volts in response to an input of positive or negative 6 volts.
- Rated power: 4K watts
- Actual power: 2K watts
- Rated temperature: 0 to 50° C.
- Actual temperature: Ambient.

Test:

- a. OMRSD file VI requires verification of proper performance of the bridge operational test annually.
- b. OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.
- c. OMI Q3008, Pre-Operation Setup Instructions, requires a verification of proper operation of the overvoltage protection relay prior to all critical lifts.

Inspection:

- OMI Q6003, Maintenance Instructions, will require an annual visual inspection of the solid state circuit board assemblies for evidence of burning, discoloration caused by over-heating, contamination or corrosion.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations, by returning the Master Control Switch to neutral or pressing the E-Stop button.
 - 3) When the failure occurs in the fine speed mode, the motor generator set will be shut down by an overvoltage protection relay when the voltage in the DC motor loop reaches 115% of full fine voltage (see Test item c for operational verification information).
 - 4) Operationally, the crane must be operated in the fine speed mode if a critical load is within 10 feet of any structure.
 - 5) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 6) During all critical lifts, there is at least one remote Emergency Stop (E-Stop) operator observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Synchro Transmitter and Receiver Assembly, Bridge

Find Number: 3SYNT/3SYNR

Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA		PMN/	K60-0528/
Part No:	NA	Name:	175-Ton Bridge Crane/VAB
Mfg/	General Electric/	Drawing/	67-K-L-11348/
Part No:	2JDA66PA10A, 5PY-5GTY23	Sheet No:	23

Function: Provides bridge position and motion indication to the operator in the cab. The operator uses this indicator to determine movement distance when required to make small incremental moves for mate/demate operations.

Critical Failure Mode/Failure Mode No: Erroneous Output (indication)/09FY12-006.114

Failure Cause: Corrosion, binding mechanism

Failure Effect: Loss of accurate position indication or load motion indication could result in improper load positioning. The worst case would be attempting to mate or demate an External Tank (ET) or the aft end of the orbiter from the transporter, the failure occurring, and the effect being the operator commanding too much movement and the ET or orbiter contacting the transporter. Possible damage to vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Ratings</u>	<u>Actual</u>
115 volts	120 volts

- Totally enclosed nonventilated cast housing.
- Motor-type rotor is the only moving part.
- This item was off-the-shelf hardware selected by the crane manufacturer for this application.

Test:

- OMRSD file VI requires verification of proper performance of the bridge operational test annually.

- OMI Q3008, Operating Instructions, requires all crane systems to be operated briefly in all speeds to verify satisfactory operation before lifting operations.

Inspection:

- OMI Q6003, Maintenance Instructions, require monthly inspection for quietness and smoothness during operation; monthly inspection of belt drives for worn, frayed or abnormal wear; monthly inspection for broken, bent or badly worn pulleys; monthly verification by examination and manipulation that keys and couplings are securely in place; annual removal and inspection of brushes and replacement of brushes when overall length is 3/8-inch or less.

Failure History:

- The PRACA database was researched and failure data was found on this component in the critical failure mode.
 - The failures occurred on 3/9/91, 10/10/91, and 10/8/92.
 - The failure cause was binding mechanism.
 - The correcting action was to remove and replace the selsyn receiver (3/9/91), or to remove, repair and replace the selsyn receiver (10/10/91 & 10/8/92).

NOTE: These failures did not necessarily occur on this crane drive system. The failure may have occurred on any one of the drive systems of this crane or one of the two VAB 250-Ton Bridge Cranes.

- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) When the failure indication is noticed, the operator can stop all crane operations by returning the Master Control Switch to neutral or pressing the E-Stop button.
 - 2) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 3) During all critical lifts, there is at least one remote Emergency Stop (E-Stop) operator observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Potentiometer, Trolley
Find Number: RPOT
Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA		PMN/	K60-0528/
Part No:	NA	Name:	175-Ton Bridge Crane/VAB
Mfg/	Ohmite/	Drawing/	67-K-L-11348/
Part No:	RHS750	Sheet No:	27

Function: Reference potentiometer connected to the master control switch, 4MC, (joystick) to control the input excitation voltage to the generator field DC input controller, 4FC, and the resulting output to the generator field winding for trolley speed control during operations.

Critical Failure Mode/Failure Mode No: Fail open/09FY12-006.116

Failure Cause: Corrosion, fatigue

Failure Effect: If the failure occurs on the resistive element, it would result in a loss of the parallel resistance branch which will create a larger input into the generator field DC input controller which will cause an increasing speed of the DC motors controlling the trolley. The worst case would be attempting to move an External Tank (ET) or the aft end of the orbiter while in the coarse mode of operation, the failure occurring, causing a sudden increase to full coarse speed and the effect being the ET or the aft end of the orbiter striking the VAB wall or platform, resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Rated Power</u>	<u>Actual Power</u>
25 watts	.18 watts
<u>Rated Voltage</u>	<u>Actual Voltage</u>
300 volts	12 volts
<u>Rated Current</u>	<u>Actual Current</u>
.176 amps	.015 amps

- Material:
 - Body: Ceramic
 - Windings: High grade resistance alloy
 - Coating: Vitreous enamel
 - Contact Arm: Metal graphite composition
 - Terminals: Solder coated
- Resistance tolerance: +/- 10 %

Test:

- OMRSD file VI requires verification of proper performance of the trolley operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.
- OMI Q3008, Pre-Operation Setup Instructions, requires current limit checks prior to all major lifts of flight hardware (verifies motor, generator, generator field DC input controller, float control loop and DC power loop components are operational).

Inspection:

- This item is not readily accessible for inspection. OMI Q6003, Maintenance Instructions, instructs that inspections shall not entail disassembly of equipment.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by returning the Master Control Switch to neutral or pressing the E-Stop button.
 - 3) If the speed increase failure occurs in the fine speed mode of operation, the motor generator set will be shut down by an overvoltage protection relay when the voltage in the DC motor loop reaches 115% of full fine voltage.
 - 4) Operationally, the crane must be operated in the fine speed mode if a critical load is within 10 feet of any structure.
 - 5) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.

- 6) During all critical lifts, there is at least one remote Emergency Stop (E-Stop) operator observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Generator Field DC Input Controller, Trolley

Find Number: 4FC

Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA		PMN/	K60-0528/
Part No:	NA	Name:	175-Ton Bridge Crane/VAB
Mfg/	Reflex/	Drawing/	67-K-L-11348/
Part No:	URRK-VIII	Sheet No:	27

Function: A solid state assembly which provides DC excitation to the generator field of the motor-generator set (M6-G2). The excitation is proportional to the input supplied from the control potentiometer (R POT) and is used to drive the DC motors which control the trolley.

Critical Failure Mode/Failure Mode No:

- a. High output (not inverted)/09FY12-006.076
- b. High output (inverted)/09FY12-006.077

Failure Cause:

- a. Board component short, board component open, loss of voltage feedback from the DC drive motor loop.
- b. Board component short.

Failure Effect:

- a. Increasing speed of the DC motors controlling the trolley. The worst case would be attempting to move the ET or the orbiter to the east or west in the slow coarse mode of operation, while suspended above the VAB transfer aisle, the failure occurring causing a sudden increase to full coarse speed resulting in the ET or the orbiter striking the wall of the transfer aisle at a velocity of 50 ft/min causing possible damage to a vehicle system. Time to effect: seconds.
- b. Increasing speed, in the opposite direction than commanded, of the DC motors controlling the trolley. The worst case would be attempting to move the ET or the orbiter to the east or west in the slow coarse mode of operation, while suspended above the VAB transfer aisle, the failure occurring causing a sudden increase to full coarse speed resulting in the ET or the orbiter striking the wall of the transfer aisle at a velocity of 50 ft/min causing possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

- Voltage feedback from the DC motor armature loop maintains a constant output to the drive motors at $\pm 2\%$. This prevents an overvoltage condition from driving the crane faster than is commanded by the operator.
- Current feedback from the DC motor armature loop prevents the crane from being driven faster than is allowable in maximum coarse speed.
- Current feedback from the generator field winding maintains the proper gating for output to the generator field.
- Output can be regulated and will remain constant each time the crane is being used. This allows for uniformity in expected crane reactions to inputs from the operator.
- Output to the generator field is supplied up to positive or negative 109 volts in response to an input of positive or negative 6 volts.
- Rated power: 4K watts
- Actual power: 2K watts
- Rated temperature: 0 to 50° C.
- Actual temperature: Ambient.

Test:

- a. OMRSD file VI requires verification of proper performance of the trolley operational test annually.
- b. OMI Q3008, Operating Instructions, requires all crane systems be operated briefly in all speeds to verify satisfactory operation before lifting operations.
- c. OMI Q3008, Pre-Operation Setup Instructions, requires a verification of proper operation of the overvoltage protection relay prior to all critical lifts.

Inspection:

- OMI Q6003, Maintenance Instructions, will require an annual visual inspection of the solid state circuit board assemblies for evidence of burning, discoloration caused by overheating, contamination or corrosion.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by returning the Master Control Switch to neutral or pressing the E-Stop button.
 - 3) When the failure occurs in the fine speed mode, the motor generator set will be shut down by an overvoltage protection relay when the voltage in the DC motor loop reaches 115% of full fine voltage (see Test item c for operational verification information).
 - 4) Operationally, the crane must be operated in the fine speed mode if a critical load is within 10 feet of any structure.
 - 5) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 6) During all critical lifts, there is at least one remote Emergency Stop (E-Stop) operator observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Synchro Transmitter and Receiver Assembly, Trolley
Find Number: 4SYNT/4SYNR
Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA		PMN/	K60-0528/
Part No:	NA	Name:	175-Ton Bridge Crane/VAB
Mfg/	General Electric/	Drawing/	67-K-L-11348/
Part No:	2JDA66PA10A, 5PY-5GTY23	Sheet No:	28

Function: Provides trolley position and motion indication to the operator in the cab. The operator uses this indicator to determine movement distance when required to make small incremental moves for mate/demate operations.

Critical Failure Mode/Failure Mode No: Erroneous Output (indication)/09FY12-006.117

Failure Cause: Corrosion, binding mechanism

Failure Effect: Loss of accurate position indication or load motion indication could result in improper load positioning. The worst case would be attempting to mate or demate an External Tank (ET) or the aft end of the orbiter from the transporter, the failure occurring, and the effect being the operator commanding too much movement and the ET or orbiter contacting the transporter. Possible damage to vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Ratings</u>	<u>Actual</u>
115 volts	120 volts

- Totally enclosed nonventilated cast housing.
- Motor-type rotor is the only moving part.
- This item was off-the-shelf hardware selected by the crane manufacturer for this application.

Test:

- OMRSD file VI requires verification of proper performance of the trolley operational test annually.

- OMI Q3008, Operating Instructions, requires all crane systems to be operated briefly in all speeds to verify satisfactory operation before lifting operations.

Inspection:

- OMI Q6003, Maintenance Instructions, require monthly inspection for quietness and smoothness during operation; monthly inspection of belt drives for worn, frayed or abnormal wear; monthly inspection for broken, bent or badly worn pulleys; monthly verification by examination and manipulation that keys and couplings are securely in place; annual removal and inspection of brushes and replacement of brushes when overall length is 3/8-inch or less.

Failure History:

- The PRACA database was researched and failure data was found on this component in the critical failure mode.
 - The failures occurred on 3/9/91, 10/10/91, and 10/8/92.
 - The failure cause was binding mechanism.
 - The correcting action was to remove and replace the selsyn receiver (3/9/91), or to remove, repair and replace the selsyn receiver (10/10/91 & 10/8/92).

NOTE: These failures did not necessarily occur on this crane drive system. The failure may have occurred on any one of the drive systems of this crane or one of the two VAB 250-Ton Bridge Cranes.

- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) When the failure indication is noticed, the operator can stop all crane operations by returning the Master Control Switch to neutral or pressing the E-Stop button.
 - 2) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 3) During all critical lifts, there is at least one remote Emergency Stop (E-Stop) operator observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Circuit Breaker
Find Number: 12CB
Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA	NA	PMN/	K60-0528/
Part No:		Name:	175-Ton Bridge Crane/VAB
Mfg/	General Electric/	Drawing/	67-K-L-11348/
Part No:	TEF134040	Sheet No:	26

Function: Provides overcurrent protection for the motor field windings and brake solenoids on all four drive systems.

Critical Failure Mode/Failure Mode No: Contact Fails Open (1 of 3)/09FY12-006.118

Failure Cause: Corrosion, fatigue

Failure Effect: The voltage supplied to transformer 4TR3 will be diminished. The resultant DC voltage to the motor field windings will be reduced. The field will be weakened by the reduction of current through the windings. The hoist will descend at a higher rate of speed than expected (speed will be approximately double of the commanded input). The worst case scenario would be lowering an External Tank (ET) or the aft end of an orbiter in the coarse speed mode (maximum coarse speed is 10 ft/min), the failure occurring causing the hoist speed to increase to approximately two times the commanded speed, resulting in the ET or the aft end of the orbiter striking the VAB floor or transporter resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Ratings</u>	<u>Actual</u>
480 volts	440 volts
40 amps	Testing required

- This component was off-the-shelf hardware selected by the crane manufacturer for this application.

Test:

- OMRSD File VI requires verification of proper performance of both hoists, bridge and trolley operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems to be operated briefly in all speeds to verify satisfactory operation before lifting operations.

Inspection:

- OMI Q6003, Maintenance Instructions, requires annual inspection of electrical components and wiring for evidence of corrosion, overheating or burning.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by pressing the E-Stop button.
 - 3) Operationally, the crane must be operated in the fine or float speed mode if a critical load is within 10 feet of any structure.
 - 4) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 5) During all critical lifts, there is at least one remote Emergency Stop (E-Stop) operator observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

B/L: 389.00
SYS: 175-TON
BRIDGE
CRANE, VAB

Critical Item: Transformer
Find Number: 4TR3
Criticality Category: 2

SAA No:	09FY12-006	System/Area:	175-Ton Bridge Crane/VAB
NASA	NA	PMN/	K60-0528/
Part No:		Name:	175-Ton Bridge Crane/VAB
Mfg/	General Electric/	Drawing/	67-K-L-11348/
Part No:	Style # 9T21A1004	Sheet No:	26

Function: This transformer steps down the 3 phase 440 VAC, to 240 VAC to be fed into a rectifier which establishes the 183 VDC for use in the motor field windings on all four drive systems.

Critical Failure Mode/Failure Mode No:

Winding Fails Open or Shorted/09FY12-006.119

Failure Cause: Corrosion, fatigue

Failure Effect: The voltage supplied to the rectifier will be diminished. The resultant DC voltage to the motor field windings will be reduced. The field will be weakened by the reduction of current through the windings. The hoist will descend at a higher rate of speed than expected (speed will be approximately double of the commanded input). The worst case scenario would be lowering an External Tank (ET) or the aft end of an orbiter in the coarse speed mode (maximum coarse speed is 10 ft/min), the failure occurring causing the hoist speed to increase to approximately two times the commanded speed, resulting in the ET or the aft end of the orbiter striking the VAB floor or transporter resulting in possible damage to a vehicle system. Time to effect: seconds.

ACCEPTANCE RATIONALE

Design:

<u>Ratings</u>	<u>Actual</u>
5000 volt-amps	Testing required

- This component was off-the-shelf hardware selected by the crane manufacturer for this application.

Test:

- OMRSD File VI requires verification of proper performance of both hoists, bridge and trolley operational test annually.
- OMI Q3008, Operating Instructions, requires all crane systems to be operated briefly in all speeds to verify satisfactory operation before lifting operations.

Inspection:

- OMI Q6003, Maintenance Instructions, requires annual inspection of electrical components and wiring for evidence of corrosion, overheating or burning.

Failure History:

- The PRACA database was researched and no failure data was found on this component in the critical failure mode.
- The GIDEP failure data interchange system was researched and no failure data was found on this component in the critical failure mode.

Operational Use:

- Correcting Action:
 - 1) The failure can be recognized via the Selsyn (positions change) that is in view of both operators.
 - 2) When the failure indication is noticed, the operator can stop all crane operations by pressing the E-Stop button.
 - 3) Operationally, the crane must be operated in the fine or float speed mode if a critical load is within 10 feet of any structure.
 - 4) Operators are trained and certified to operate these cranes and know and understand what to do if a failure indication is present.
 - 5) During all critical lifts, there is at least one remote Emergency Stop (E-Stop) operator observing the load lift, and can stop the crane if a failure indication is noticed.
- Timeframe:
 - Estimated operator reaction time is 3 to 10 seconds.

7.0 HAZARD ANALYSIS

The hazard analysis for the 175-Ton Bridge Crane at the Vehicle Assembly Building was conducted in accordance with NSTS 22254 and KHB 5310.9. The objective of this analysis is to:

- Document the hazards identified from the analysis of the system.
- Provide visibility of the risks associated with operation of the system.
- Evaluate the adequacy of existing controls for the identified hazards.
- Propose additional controls and new hazard reports as required.

7.1 SAFETY CRITICALITY ASSESSMENT

The 175-Ton Bridge Crane System is assessed as Safety Critical because failure of the system during lifting operations could result in personnel injury/loss of life and/or flight hardware damage/loss.

7.2 SCOPE

The following were assessed in the preparation of this hazard analysis:

- Design hazards that could result in damage to flight hardware or injury to personnel.
- Operational/procedural hazards that occur during system use.
- Functional interfaces to determine if any hazardous conditions exist across the interfaces upstream and downstream of the equipment/system.

7.3 SUMMARY OF ANALYSIS

The 175-Ton Bridge Crane at the Vehicle Assembly Building (VAB) was analyzed with emphasis on mechanical and electrical aspects. Associated drawings in the SAA were reviewed and a walkdown of the system was performed. A KSC/RT Safety and Reliability Hazard Data Base search was performed by baseline number, program model number and station set. There were one controlled and two accepted risk hazard reports identified during this search. There were no new hazard reports generated as a result of this analysis. Hazard Report RT-ENG-1027, which identifies the potential for personnel injury/loss of life and/or flight hardware damage/loss resulting from failure of the VAB 250/175-Ton Cranes and associated lifting equipment, will be updated to include the critical items associated with the 175-Ton Bridge Crane as identified in this analysis. The attached hazard reports provide additional information.

An assessment was performed for compliance with NSS/GO 1740.9B, NASA Safety Standard for Lifting Devices and Equipment. NSS/GO 1740.9B, 201g.(4), states "Controls shall return to the off position when the operator relieves pressure." The spring-return feature has been removed from the control levers of the 175-Ton Bridge Crane in order to reduce possible operator fatigue during prolonged operations. However, during critical operations, two operators are located in the control cab. In addition, remote emergency-stop operators are positioned in view of the load at all times.

The 175-Ton Bridge is also in non-compliance with NSS/GO 1740.9B in that the crane's hooks are not provided with a hook safety latch. NSS/GO 1740.9B, 201f.(d), states "Latch-equipped hooks shall be used unless the application makes the use of a latch impractical or unnecessary. When required, a latch or mousing shall be provided to bridge the throat opening of the hook to retain slings, chains or other similar parts under slack conditions." Use of a hook latch on the main hoist hook is unnecessary. All critical lifts by the main hoist use the hook center hole for pinning lifting equipment.

In addition, NSS/GO 1740.9B, 201g.(9), states "For cranes used for critical lifts, dual upper limit switches are required." The 175-Ton Bridge Crane hoists are equipped with a single upper limit switch which can be backed out of by the operator should the limit switch be engaged. Operators are warned, per OMI Q3008, not to use the limit switch to stop crane motion during lifting operations. In the event of a control failure, operators can halt crane motion using the operator emergency-stop. Observers equipped with remote emergency-stops are also positioned in view of the load at all times. Preventive maintenance and operational testing is performed periodically per OMI Q6003. Engineering Support Request (ESR) K13962 has been submitted to correct this discrepancy. The aforementioned non-compliances have been accepted by the Launch and Landing Level III Configuration Control/SPC Risk Review Board.

The attached Hazard Analysis Documentation Sheet, Fault Tree Analysis and Columnar Format Sheets provide additional information.

HAZARD ANALYSIS DOCUMENTATION

SAA Number

System / Subsystem

SAA09FY12-0067

175-Ton Bridge Crane, VAB

See SAA Cover Sheet for applicable Baseline Number(s), Program Model Number(s), Work Unit Code(s) and Station Set(s).

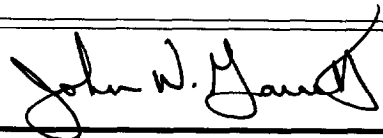
The Hazard Analysis was based on the following documentation:

Document NumberTitle

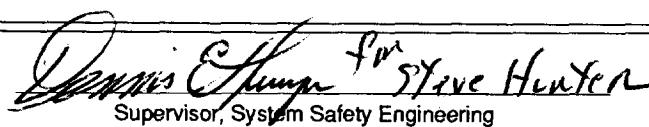
GP 1098F	KSC Ground Safety Plan
NSTS 22254	Methodology For Conduct Of NSTS Hazard Analyses
NSS/GO-1740.9B	NASA Safety Standard For Lifting Devices & Equipment
29 CFR 1910	Occupational Safety & Health Administration, Labor Regulations
79K16830	Mechanical Arrangement 175-Ton Bridge Crane, VAB
67-K-L-11348	VAB 175-Ton Bridge Crane Electrical
79K05056	Modifications of 175-Ton & 250-Ton Bridge Cranes
OMI Q3008	Operating Instructions For The 175-Ton & 250-Ton Bridge Cranes, VAB
OMI Q6003	Maintenance Instructions For the 175-Ton & 250-Ton Bridge Cranes, VAB

Safety Engineer

John Garrett



Approved


Supervisor, System Safety Engineering

KSC HAZARD REPORT printed 04/01/93 08:51:01 Contractor: LSOC page 0

HAZARD NUMBER: RT-ENG-1027 DATE IDENTIFIED: 02/08/89
STATUS (O/C): C MASTER # K-SPC-00396-S-CR TEAM: RT LOG # 32TITLE: FLIGHT HARDWARE DAMAGE/LOSS AND/OR PERSONNEL INJURY/DEATH DUE TO VAB
250/175 TON CRANE OR LIFTING GSE FAILURERESP. ORGANIZATION: LSOC
LOCATION/STATION SETS: 20
BASELINES: 389.00
PROGRAM MODEL NOS.: H70-0597-02, H77-0384-01, H77-0384-02, H77-0384-03, H78-3006
EFFECTIVITY/MISSION: 30+
SEE ADDITIONAL REFERENCES FOLLOWING REMARKSEQUIPMENT CATEGORY: F A-SHUTTLE HARDWARE C-SHUTTLE/GSE E-SUPPORT EQUIP.
B-PAYLOAD HARDWARE D-PAYLOAD/GSE F-FACILITY/SITE

RESOLUTION DOC.-- (ESR, EO, INC., OMI, OMRSD FILE 6, OTHER)

CR NUMBER: 50414D
FMEA/CIL: 09FY12-005/-006 TITLE: 250/175 TON BRIDGE CRANES (VAB)
OMRSD NUMBER: TITLE:
OMI NUMBERS: B5303, Q3008, Q6003, S0003, S0004, T6047, T6048
ESRS: K14184
OTHER:

TYPE OF HAZARD: A A-DESIGN B-OPERATIONAL C-OTHER

TYPE OF ANALYSIS: D A-PRELIMINARY B-SUBSYSTEM C-SYSTEM D-OPERATING&SUPP.

HAZARD CLOSURE CLASS.: A E-ELIMINATED C-CONTROLLED A-ACCEPTED RISK

HAZARD LEVEL: CA CA-CATASTROPHIC CR-CRITICAL CN-CONTROLLED

HAZARD GROUP: I SEVERITY: C_s PROBABILITY: A₀

PREPARED BY: D A-SPC B-BOC C-PGOC D-Other

SAFETY ENGINEER: J. BRANARD/RT-ENG-1 DATE: 02/08/89

CONTRACTOR MGMT. APPROVAL(1): JOHN W. JAMBA DATE: 02/14/89

CONTRACTOR MGMT. APPROVAL(2): WILLIAM H. SCHICK DATE: 02/15/89

NASA APPROVALS(1): J. ROBERT LANG DATE: 02/16/89

NASA APPROVALS(2): J. A. THOMAS DATE: 02/17/89

DATE APPROVED: CCB: 03/17/89 SSRP: 03/29/89 PRCB: 04/11/89

FUNCTION KEY: S S-NSTS/SHUTTLE I-INDUSTRIAL P-PAYLOAD
A-ADMINISTRATIVE O-OTHER CENTER/CONTRACTOR

KSC Computerized 6-32

KSC HAZARD REPORT printed 04/01/93 08:51:02 Contractor: LSOC page 1

HAZARD NUMBER: RT-ENG-1027 DATE IDENTIFIED: 02/08/89
STATUS (O/C): C MASTER # K-SPC-00396-S-CR TEAM: RT LOG # 32TITLE: FLIGHT HARDWARE DAMAGE/LOSS AND/OR PERSONNEL INJURY/DEATH DUE TO VAB
250/175 TON CRANE OR LIFTING GSE FAILURE**HAZARD DESCRIPTION:**

Two 250-Ton VAB cranes and a 175-Ton VAB crane are utilized to perform major VAB lifting operations (e.g., SRB Stacking, ET/SRB Mate, and Orbiter/ET Mate). These cranes are electric bridge cranes with main hook load capacities of 250 Tons and 175 Tons, respectively, and an auxiliary hook load capacity of 25 tons. Both 250-Ton cranes operate on crane rails 466 feet above the VAB floor. One crane runs between High Bays 1 and 2, with the second crane running between High Bays 3 and 4. The 175-Ton crane is operated on crane rails 168 feet above the VAB floor. The 175-Ton crane runs along the length of the VAB transfer aisle. Crane motions are controlled from the console in the crane operator's cab (located under one bridge truss). The four major crane control capabilities are: a) Hoisting and lowering the main and auxiliary load hooks; b) Traverse movement of the trolley across the bridge; c) Traverse of the crane along the craneway; and d) Main hook swiveling.

The crane operator's cab is equipped with four lever-operated master switches. These switches control movements of the main and auxiliary hoist load blocks, and trolley and bridge travel. Each lever has a ball end with a thumb latch on top. The thumb latch is a lock for the neutral position of the lever only. Pressing down on the thumb latch releases the master switch lever from the "OFF" position. Each master switch lever is provided with a squeeze-type lever at the side. The function of the lever is to enable brake release when required by the master switch lever for float control. The master switches are stepless. Motor speed, which is controlled by the master switch, is proportional to the displacement or movement of the switch lever from the neutral position. Full displacement will produce maximum motor speed. There are no detents or steps. Master switches are arranged on the cab console so that the crane will move in the direction in which the lever is pushed.

The main hoist, auxiliary hoist, trolley and bridge drives are redundant configurations utilizing motor-generator sets that supply energy to the DC final drive motors. The DC drive system provides for floating the load, very slow speeds for setting or starting the load, rapid hoisting and lowering of an empty hook, regenerative braking, and very precise and smooth control of crane movements.

The specific VAB crane(s) and lifting hardware/GSE utilized for major VAB crane lifting operations are:

- A. SRB Stacking (OMI B5303) is accomplished using the 250-Ton crane, the SRM Four-Point Lifting Beam System (H77-0384-01,-02,-03), and the 250-Ton Hydraset (H72-0828-11). The 25-Ton auxiliary hoist is used to stack the SRB nose cap.
- B. ET/SRB Mate (OMI S0003) uses both the 250-Ton and 175-Ton cranes, and the ET Forward Sling Set (H78-3006-00).
- C. Orbiter/ET Mate (OMI S0004) uses both the 250-Ton and 175-Ton cranes, and

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HAZARD NUMBER: RT-ENG-1027

DATE IDENTIFIED: 02/08/89

STATUS (O/C): C

MASTER # K-SPC-00396-S-CR

TEAM: RT

LOG # 32

TITLE: FLIGHT HARDWARE DAMAGE/LOSS AND/OR PERSONNEL INJURY/DEATH DUE TO VAB
250/175 TON CRANE OR LIFTING GSE FAILURE

HAZARD DESCRIPTION: (Cont'd)

the Orbiter Mating Sling Set (H70-0597-02).

During critical VAB crane lifting/mating operations, the potential exists for flight hardware damage/loss and/or personnel injury/death due to 250/175-Ton crane or lifting GSE failures that cause the load to fall.

HAZARD CAUSE(S):

1. Failure of 250/175-Ton VAB crane critical items (Criticality 1 and 2) in the main and auxiliary hoist DC power and control loops. All critical items in the main hoist DC power and control loops are Criticality 1, except for Brake Switch S1, which is a Criticality 2 item. All auxiliary hoist critical items are Criticality 2. Critical items are summarized below:

CRITICAL ITEM NAME	QUANTITY (PER CRANE)	CRITICAL FAILURE MODE(S)	FAILURE EFFECT
DC Power Loop (Main Hoist):			
Main Hoist Motor-Generator Set (M12-G4)	1	No Output	Load Drops
Main Hoist Motor (M13,M14)	2	Open Armature Winding	Load Drops
DC Control Loop (Main Hoist):			
Master Control Switch (1MC)	1	Contact Fails Closed	Load Drops
Hoist Control Relay (1HCR,1LCR)	2	N.O. Contact Fails Open or Closed	Load Drops
Suicide Gen. Relay (HCR RUN,LCR RUN)	2	Coil Fails Open; N.O. Contact Fails Open; N.C. Contact Fails Closed	Load Drops
Main Brake Relay (1XR)	1	N.O. Contact Fails Closed	Load Drops
Bridge Rectifier (3 RECT)	1	Fails Open	Load Drops

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HAZARD NUMBER: RT-ENG-1027

DATE IDENTIFIED: 02/08/89

STATUS (O/C): C MASTER # K-SPC-00396-S-CR

TEAM: RT LOG # 32

TITLE: FLIGHT HARDWARE DAMAGE/LOSS AND/OR PERSONNEL INJURY/DEATH DUE TO VAB
250/175 TON CRANE OR LIFTING GSE FAILURE

HAZARD CAUSE(S): (Cont'd)

or Shorts

Contactor Relay (1 RUN)	1	Pull-In Coil Fails Open; N.O. Contact Fails Open	Load Drops
Fixed Resistor (1RS1,1RS2,1RS3, 1RS4,1RS5,1RS6,1RS7,1RS8,1RS9,1RS10) [NOTE: 175-Ton Crane does not have 1RS2 or 1RS8]	10	Fails Open	Load Drops
Potentiometer (1P,2P,3P)	3	Fails Open	Load Drops
Potentiometer (R POT)	1	Fails Open	Load Drops
Foot Switch (S2)	1	Fails Open	Load Drops
Potentiometer (F POT)	1	Fails Open	Load Drops
Potentiometer (4P)	1	Fails Open	Load Drops
Ammeter (1AM)	1	Shunt Fails Open	Load Drops
Metadyne Motor-Generator Set (M27-G5)	1	No Output	Load Drops
Voltage Relay (1VR)	1	N.O. Contact Fails Closed	Load Drops
DC Power Loop (Auxiliary Hoist):			
Auxiliary Hoist Motor-Generator Set (M9-G3)	1	No Output	Load Drops
Auxiliary Hoist Motor (M10,M11)	2	Open Armature Winding	Load Drops
DC Control Loop (Auxiliary Hoist):			
Master Control Switch (2MC)	1	Contact Fails Closed	Load Drops

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DATE IDENTIFIED: 02/08/89

STATUS (O/C): C MASTER # K-SPC-00396-S-CR

TEAM: RT LOG # 32

TITLE: FLIGHT HARDWARE DAMAGE/LOSS AND/OR PERSONNEL INJURY/DEATH DUE TO VAB
250/175 TON CRANE OR LIFTING GSE FAILURE

HAZARD CAUSE(S): (Cont'd)

Hoist Control Relay (2HCR,2LCR)	2	N.O. Contact Fails Open or Closed	Load Drops
Suicide Gen. Relay (HCR RUN,LCR RUN)	2	Coil Fails Open; N.O. Contact Fails Open; N.C. Contact Fails Closed	Load Drops
Main Brake Relay (2XR)	1	N.O. Contact Fails Closed	Load Drops
Bridge Rectifier (4 RECT)	1	Fails Open	Load Drops
Contactor Relay (2 RUN)	1	Pull-In Coil Fails Open; N.O. Contact Fails Open	Load Drops
Fixed Resistor (2RS1,2RS2,2RS3,2RS4, 2RS5,2RS6,2RS7,2RS8,2RS9,2RS10) [NOTE: 175-Ton Crane does not have 2RS2 or 2RS8]	10	Fails Open	Load Drops
Potentiometer (1P,2P,3P)	3	Fails Open	Load Drops
Potentiometer (R POT)	1	Fails Open	Load Drops
Foot Switch (S2)	1	Fails Open	Load Drops
Potentiometer (F POT)	1	Fails Open	Load Drops
Potentiometer (4P)	1	Fails Open	Load Drops
Ammeter (1AM)	1	Shunt Fails Open	Load Drops
Metadyne Motor-Generator Set (M28-G6)	1	No Output	Load Drops
Voltage Relay (2VR)	1	N.O. Contact Fails Closed	Load Drops

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HAZARD NUMBER: RT-ENG-1027 DATE IDENTIFIED: 02/08/89
STATUS (O/C): C MASTER # K-SPC-00396-S-CR TEAM: RT LOG # 32TITLE: FLIGHT HARDWARE DAMAGE/LOSS AND/OR PERSONNEL INJURY/DEATH DUE TO VAB
250/175 TON CRANE OR LIFTING GSE FAILURE

HAZARD CAUSE(S): (Cont'd)

NOTE: With a segment (approximately 175-tons forward) loaded on the crane hook, failure of DC power loop critical items will allow the load to fall as follows: after 0.1 seconds, 0.006 inches; after 0.5 seconds, 0.150 inches; after 1.0 seconds, 0.600 inches; after 2.0 seconds, 2.40 inches. Failure of DC control loop critical items will allow the load to fall at a slower rate due to the regenerative braking characteristics of the DC power loop.

2. Failure of the lifting hardware/GSE used during 250/175-Ton VAB crane lifting operations:

- A. SRM Four-Point Lifting Beam System (H77-0384-01,-02,-03).
- B. 250-Ton Hydraset (H72-0828-11).
- C. ET Forward Sling Set (H78-3006-00).
- D. Orbiter Mating Sling Set (H70-0597-02).

HAZARD EFFECT(S):

Failure of 250/175-Ton crane DC power loop critical items results in loss of the DC power loop and falling of the load. Failure of DC control loop critical items results in loss of DC input to DC control when hoist brakes are released, and the load falls. These effects and/or failures associated with the lifting hardware could result in damage/loss of flight hardware (SRB segment, ET, Orbiter), GSE, and/or personnel injury/death (loss of the VAB facility due to inadvertent ignition of an SRM segment has been addressed previously in KSC Hazard Report IHA-019).

ENGINEERING/SAFETY REQUIREMENTS:

NSTS 07700, Volume X, Paragraph 3.5.1.2.1.1, GSE Fail Safe Requirement.

ELIMINATION/CONTROL/ACCEPTED RISK RATIONALE:

The risk of hazard occurrence is reduced to an acceptable level based on the following controls:

1A. The 250/175-Ton cranes have appropriate design safety factors and meet industry standards as a minimum. The cranes are in compliance with all NSS/GO-1740.9 (NASA Standard for Lifting Devices and Equipment) design requirements except for dual upper limit switches (paragraph 2.2.7.i). The crane motor generator set is equipped with automatic overspeed protection, which is engaged during critical lifting operations. OMI Q6003 performs extensive monthly, quarterly, semi-annual, annual, and biennial preventive maintenance and testing of the 250/175-Ton cranes to ensure readiness to support lifting operations. Preventive maintenance includes visual checks, adjustments, lubrication, cleaning, repairs and/or parts replacement, and system operation under no-load and 100% load conditions.

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STATUS (O/C): C MASTER # K-SPC-00396-S-CR TEAM: RT LOG # 32TITLE: FLIGHT HARDWARE DAMAGE/LOSS AND/OR PERSONNEL INJURY/DEATH DUE TO VAB
250/175 TON CRANE OR LIFTING GSE FAILURE

ELIMINATION/CONTROL/ACCEPTED RISK RATIONALE: (Cont'd)

1B. The 250/175-Ton cranes are load-tested annually. Prior to lifting operations, OMI Q3008 performs several crane pre-operational checks/activities, including: a) Crane status check; b) Visual crane inspection; c) Establishment of a 25-foot control area; d) Crane inspections from the bridge and trolley catwalks; e) Establishment of operator communications; f) Upper limit switch testing; g) Motor, generator, and metadyne checks; and h) Current limit checks.

1C. OMI Q6003 requires semi-annual inspection of motor-generator set components, as well as an annual inspection of all critical item relays, switch contacts and contact members for burning, pitting, proper alignment, and discoloration caused by overheating. Closing coils are visually checked for deteriorated insulation and evidence of overheating or burning.

1D. Critical item failures are immediately recognizable by the crane operator via an ammeter (loss of current) or Selsyn position indicator (position changes). When failure indication is noticed, crane operators secure the load in accordance with well-defined emergency instructions. A one-second response time (maximum) is required to secure the load.

1E. Ground controllers and E-stop operators are properly positioned during all phases of the lifting operation in full view of the load block, lifting fixtures, and fixture attach points. At least one E-stop operator, remote from the crane operator's cab, can stop the crane if a failure indication is observed.

1F. During SRB Stacking, the 250-Ton crane is normally in the "OFF" position and the 250-Ton Hydraset is used for final segment mating (when segment is within one foot of mate). When the crane is OFF and the hydraset is being used, none of the aforementioned critical item failure modes are credible.

1G. When hoisting critical loads within three feet of flight hardware or structures, the "float" control mode is used, which builds current (torque) in the hoist motors (this current is monitored by the operator prior to releasing the brakes). This operational mode serves as a "self-test" which verifies that critical item failure has not occurred.

1H. All crane operators are certified and licensed per KMI 6430.4, Examination and Licensing of KSC Facility Crane Operators. Annual physicals for crane operators are required. Current crane operator certification is verified prior to lifting operations.

2A. The SRM Four-Point Lifting Beam was designed per KSC-DE-512-SM, Guide for Design Engineering of GSE for use at KSC, and SW-E-0002, Space Shuttle Program GSE General Design Requirements. The lifting beam has a design safety factor of

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STATUS (O/C): C MASTER # K-SPC-00396-S-CR TEAM: RT LOG # 32TITLE: FLIGHT HARDWARE DAMAGE/LOSS AND/OR PERSONNEL INJURY/DEATH DUE TO VAB
250/175 TON CRANE OR LIFTING GSE FAILURE

ELIMINATION/CONTROL/ACCEPTED RISK RATIONALE: (Cont'd)

greater than 5:1 based on ultimate strength. Lifting beam maintenance is per KSC-STD-SF-0001D, Safety Standard for Lifting Devices and Equipment. The System Assurance Analysis for the SRM Four-Point Lifting Beam (SAA09FT08-017) identified no critical items.

2B. The System Assurance Analysis for the 250-Ton Hydraset (SAA00KS01-001) identified a solenoid valve and two Bal seals (piston rod and head) which are Category 2 critical items. The failure effect of any of these critical items would be a maximum 12" hydraset lowering. Nominally, hydraset lowering is limited to approximately 6" because the hydraset is set at mid-stroke prior to lifting operations. The hydraset structural design safety factor is greater than 5:1 based on ultimate strength. In accordance with NASA and Industry standards, initial proofload testing has been accomplished for all segment lifting system components. Annual load-testing and preventive maintenance are performed per KSC-STD-SF-0001D, Safety Standard for Lifting Devices and Equipment. Per the File VI OMRSD, a full operational test of the hydraset is completed prior to each lift. A self-induced load of up to 50% of the rated load is applied to test seal integrity prior to each use.

2C. The ET Forward Sling Set (H78-3006-00) has a design safety factor of 6:1 based on ultimate strength. OMI T6047 performs visual inspection and integrity verification of the sling set, as well as an annual load-test. ET Forward Sling Set preventive maintenance is accomplished per OMI T6048.

2D. The Orbiter Mating Sling Set (H70-0597-02), which is designed with a 5:1 safety factor, undergoes periodic preventive maintenance and annual load-testing.

VERIFICATION METHODS:

OMIs Q3008, Q6003, B5303, S0003, S0004, T6047, and T6048.

REMARKS/COMMENTS: (INCLUDE BACKGROUND, STATUS OF OPEN WORK, INTERFACES
WITH FLIGHT HARDWARE, OTHER CENTERS, ETC...)

REMARKS:

3/17/89 - This hazard report was approved by the Joint NASA Level III Configuration Control Board/SPC Risk Review Board.

4/11/89 - This hazard report was presented to the Level II/I PRCB and approved. Hazard cause has been updated to include 'worst case' rate of load dropping due to critical item failure. Hazard control rationale revised to reflect critical item inspection frequency. Background expanded to discuss VAB 250/175-Ton Crane modifications.

BACKGROUND:

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STATUS (O/C): C MASTER # K-SPC-00396-S-CR TEAM: RT LOG # 32TITLE: FLIGHT HARDWARE DAMAGE/LOSS AND/OR PERSONNEL INJURY/DEATH DUE TO VAB
250/175 TON CRANE OR LIFTING GSE FAILURE

REMARKS/COMMENTS: (Cont'd)

The Level II PRCB approved an interim CIL waiver for VAB 250/175-ton crane criticality 1 items on February 16, 1989. The waiver effectivity includes the following major VAB processing activities: STS-30 ET and Orbiter Mate, STS-28 flow, STS-33 flow, STS-34 ET and SRB processing, and STS-32 processing. A permanent CIL waiver is scheduled for presentation to the Level II PRCB in July 1989.

LSOC Design Engineering is pursuing a design modification which would eliminate 250/175-Ton Crane critical items. The proposed modification will : 1) provide monitoring of DC Control System to determine if a critical item failure has occurred when a zero current condition occurs during hoisting/lowering operations, and 2) provide a means of activating the hoist brakes in case of crane DC Control/Power Loop failure. Modification completion is scheduled for 1/12/90.

In response to Level II PRCB S40224MR2, KSC-TM Action Item 2-1, KSC hazard reports associated with the 250/175-Ton VAB Cranes have been updated to reference the crane critical items and hazard report RT-ENG-1027.

-IHA-019: Inadvertent Ignition of SRMs in the VAB
-RT-ENG-1019: Personnel Working Under Suspended Loads

Additional References:

Program Model Numbers:

K60-0528

K60-0533

K60-0534

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HAZARD NUMBER: RT-ENG-1019 DATE IDENTIFIED: 04/05/88
STATUS (O/C): C MASTER # K-SPC-00355-I-CR TEAM: RT LOG # 19TITLE: PERSONNEL WORKING UNDER SUSPENDED LOAD FOR SRB PROCESSING (RPSF/VAB),
ORBITER STACKING (VAB), SSME MAINTENANCE (VAB/PAD), AND MDD (SLF/CLS/KSC)RESP. ORGANIZATION: SPC/LSOC
LOCATION/STATION SETS: 20,23,29,31
BASELINES: 389.00,400.15
PROGRAM MODEL NOS.: K60-0531,K60-0533,K60-0534,K60-0562,K60-0563
EFFECTIVITY/MISSION: 26+EQUIPMENT CATEGORY: A A-SHUTTLE HARDWARE C-SHUTTLE/GSE E-SUPPORT EQUIP.
B-PAYLOAD HARDWARE D-PAYLOAD/GSE F-FACILITY/SITE

RESOLUTION DOC.-- (ESR, EO, INC., OMI, OMRSD FILE 6, OTHER)

CR NUMBER: 50504N
FMEA/CIL: SAA09FY012-005, TITLE: SAA09FY012-004
OMRSD NUMBER: 79K16835 TITLE: VARIANCE REQUEST MTI 24-80
OMI NUMBERS: B5303,B5308,B5309,Q3008,S0004,T5149,V5044,V5E06,V9005
ESRS:
OTHER:TYPE OF HAZARD: B A-DESIGN B-OPERATIONAL C-OTHER
TYPE OF ANALYSIS: D A-PRELIMINARY B-SUBSYSTEM C-SYSTEM D-OPERATING&SUPP.
HAZARD CLOSURE CLASS.: A E-ELIMINATED C-CONTROLLED A-ACCEPTED RISK
HAZARD LEVEL: CA CA-CATASTROPHIC CR-CRITICAL CN-CONTROLLED
HAZARD GROUP: I SEVERITY: C_s PROBABILITY: A₀
PREPARED BY: A A-SPC B-BOC C-PGOC D-Other

SAFETY ENGINEER: RT-ENG DATE: 04/05/88

CONTRACTOR MGMT. APPROVAL(1): JOHN W. JAMBA DATE: 04/15/88

CONTRACTOR MGMT. APPROVAL(2): LEROY B. SPIVEY DATE: 04/15/88

NASA APPROVALS(1): J. ROBERT LANG DATE: 04/18/88

NASA APPROVALS(2): J. A. THOMAS DATE: 04/23/88

DATE APPROVED: CCB: 06/07/88 SSRP: 06/22/88 PRCB: / /

FUNCTION KEY: I S-NSTS/SHUTTLE I-INDUSTRIAL P-PAYLOAD
A-ADMINISTRATIVE O-OTHER CENTER/CONTRACTOR

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HAZARD NUMBER: RT-ENG-1019 DATE IDENTIFIED: 04/05/88
STATUS (O/C): C MASTER # K-SPC-00355-I-CR TEAM: RT LOG # 19TITLE: PERSONNEL WORKING UNDER SUSPENDED LOAD FOR SRB PROCESSING (RPSF/VAB),
ORBITER STACKING (VAB), SSME MAINTENANCE (VAB/PAD), AND MDD (SLF/CLS/KSC)**HAZARD DESCRIPTION:**

Current KSC procedures for processing Solid Rocket Motors (SRMs) in the RPSF and VAB require personnel to work under a suspended load (Static). Personnel are also required to work under the Orbiter when it is lifted to the vertical position while in the VAB transfer aisle to remove landing gear pins prior to raising the gear. In the event an engine change or turbo pump change is required at the PAD, personnel would be working under the SSME area while the Orbiter is in the Vertical position on the FSS. Also, changing a turbo pump in the engine shop in the Low Bay at the VAB would require working under the engine pump when it is being installed/removed. Personnel are required to work under a suspended load when the Orbiter is mated to the Shuttle Carrier Aircraft (SCA) at DFRF and when the Orbiter is demated from the SCA at KSC to remove/install the landing gear pins. In the OPF, personnel are required to work under a suspended load during installation/removal of the Orbiter's maneuvering system (OMS) POD. They are allowed under the load when the OMS post is within 6 inches of the ball socket.

Codes applicable to working under a suspended load are as follows:

A. Occupational Safety and Health Administration (OSHA) standards, 29CFR1910 subpart "N" 1986 edition.

- a. 1910.179.n.3.vi (Overhead and Gantry Cranes) "The employer shall require that the operator avoid carrying the loads over people." (Dynamic Condition)
- b. 1910.180.h.4.ii (Crawler, Locomotive and Truck Cranes) "No person should be permitted to stand or pass under a load on the hook." (Static Condition)

B. American National Standards Institute (ANSI) 1967, 1968, & 1983 editions read the same.

- a. B30.2-3.2.3.e (Overhead and Gantry Cranes) "Loads should not be carried over people. (Dynamic Condition)
- b. B30.5-3.2.1.4.e (Crawler, Locomotive and Truck Cranes) "Loads should not be carried over people. (Dynamic Condition)

C. NASA NSS/GO-1740 dated July 1982, (January 1988 Draft read the same).

- a. Chapter 2 (Cranes) 2.7.14 "...Loads shall not be moved over people. (Dynamic Condition)

KSC/GP-1098E, Section 2.34, Ground Safety Plan, Volume 1 Safety Requirements contains requirements for a pretest briefing to be conducted just prior to the lift to ensure no open items, all systems and support personnel are ready to support. Loads are not raised, lowered or left suspended any longer than necessary to accomplish the task. In the event of a contingency or if a problem occurs during a lifting operation that prevents the completion of the task, within the shift in which it began, the load will be returned to the prelift

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HAZARD NUMBER: RT-ENG-1019 DATE IDENTIFIED: 04/05/88
STATUS (O/C): C MASTER # K-SPC-00355-I-CR TEAM: RT LOG # 19TITLE: PERSONNEL WORKING UNDER SUSPENDED LOAD FOR SRB PROCESSING (RPSF/VAB),
ORBITER STACKING (VAB), SSME MAINTENANCE (VAB/PAD), AND MDD (SLF/CLS/KSC)

HAZARD DESCRIPTION: (Cont'd)

position. However, presently there are two exceptions to this: 1) when the SRMs are suspended in the Rotating, Processing and Surge Facility (RPSF) - to be checked and inspected, and 2) during processing and stacking of the SRM segments in the VAB. In the RPSF, the air loads/fiber optic video inspection and ultrasonic inspection could require more than one work-shift. The tang inspection in the VAB requires approximately 12 hours to perform; depending on the problems identified, such as an on-bonding problem, a SRM segment could be suspended in the VAB between 2 and 8 work-shifts.

While the above loads in the RPSF and VAB are suspended, two crane operators continuously monitor the load at their control stations. One crane operator is in the cab and the other crane operator is on the ground with the emergency stop switch.

HAZARD CAUSE(S):

Failure of lifting devices: 200-ton crane in the RPSF, 250-ton crane in the VAB, 10-ton crane in the SSME shop, and the 140-ton 3900T Series 2 crane, the 800-ton TC-4000 Demag, the 250-ton HC-268 Linkbelt truck cranes, and MDD operations at the landing sites. Additional structural failures include the 250-ton hydraset and/or the SRM Four Point Lifting Beam. Any one of these failures could result in dropping the load.

HAZARD EFFECT(S):

Serious injury and/or loss of life to personnel.

ENGINEERING/SAFETY REQUIREMENTS:

KSC GP-1098E, Ground Safety Plan,
OSHA standard 29 CFR 1910, 1986 edition,
ANSI standard, 1983 edition,
NASA NSS/GO-1740, July 1982.

ELIMINATION/CONTROL/ACCEPTED RISK RATIONALE:

At the present time there is not an acceptable method to perform SRM/Orbiter processing and stacking which would prevent personnel from temporarily working under a suspended load (static condition). The necessary operations include segment cleaning, inspection, greasing, measuring, insulation debond repairs, defect analysis, and other functions associated with preparing an SRM segment for mating/stacking to minimize the hazard and reduce the risk to an acceptable level. Each lifting device was thoroughly analyzed in accordance with NSTS 22206 and NSTS 22254. The 175-ton crane, the two 200-ton cranes in the RPSF, and the two 250-ton Bridge Cranes in the VAB completed Design Certification Reviews in January 1988. The only critical items identified pertain to the 250-ton VAB cranes. These critical items are covered in hazard report RT-ENG-1027. The 200-ton cranes in the RPSF are being modified to use DC motors and controls instead of AC to eliminate erratic Trolley and bridge movement.

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HAZARD NUMBER: RT-ENG-1019

DATE IDENTIFIED: 04/05/88

STATUS (O/C): C MASTER # K-SPC-00355-I-CR

TEAM: RT LOG # 19

TITLE: PERSONNEL WORKING UNDER SUSPENDED LOAD FOR SRB PROCESSING (RPSF/VAB),
ORBITER STACKING (VAB), SSME MAINTENANCE (VAB/PAD), AND MDD (SLF/CLS/KSC)

ELIMINATION/CONTROL/ACCEPTED RISK RATIONALE: (Cont'd)

At DFRF, the MDD is used to mate the Orbiter to the SCA. At contingency landing sites, the 800-ton TC-4000 Demag and 250-ton HC-268 Linkbelt truck cranes are used to mate the Orbiter to the SCA. The MDD is used to demate the Orbiter from the SCA after it arrives at KSC. No single failure points have been identified on the MDD or the mobile crane lifting devices. Also, the pinned landing gear to be cycled require a landing gear clear area (2 ft. forward, 2 ft. each side, 2 ft. aft and gear doors clear to ground). Clearance must be acknowledged prior to raising/lowering the landing gear and/or removing/installing the gear pins.

The SRM Four-Point Lifting Beam which is used for lifting the SRMs has a design safety factor of greater than 5:1 based on ultimate yield stress. The System Assurance Analysis for the 250-ton Hydraset SAA00KS01-001, identified only one seal which is a Category 2 critical item. The failure effect would be a maximum 1/2" hydraset lowering due to O-ring failure/bleed down. The hydraset structural design safety factor is greater than 5:1 based on ultimate yield stress. In accordance with NASA and Industry standards, initial proofload testing has been accomplished for all segment lifting system components. Annual load testing and scheduled maintenance programs are currently in place (79K Documents) for the KSC lifting hardware.

SAA09FY12-011, 10-ton Bridge Crane, for the Space Shuttle Main Engines (SSME) in the VAB low bay identified two single failure points. The Gear Reducer (Criticality 1) failure mode would require disengagement or structural failure, and the Solenoid Holding Brake (Criticality 1R) failure would be failure to engage, or failure of the Mechanical Load Brake. The four hazards identified include the lack of an upper limit switch (it has one upper switch) and the undetectable failure of either the electric brake and/or the mechanical brake. The fourth hazard pertains to personnel working under a suspended load during SSME turbo pump installation which is included in this accepted risk. A safety analysis was accomplished in SAA09PPF134-001 (preliminary), Hypergol Safing System, in the OPF and indicated no single failure points. SAA09FY01-001, 30-ton Bridge Crane, indicated no single failure points. An analysis on the 10-ton Hydraset was performed in SAA00KS01-002 and indicated 2 single failure points; the seals on the piston head and the seals on the up/down pump assembly. This analysis was a generic KSC center-wide review of all the hydraulic operated hydrasets.

These in-depth system analyses of the lifting devices insure that safety and operational personnel, as well as KSC management, are aware that all potential hazards have been identified and controls established to reduce the risk of working under a suspended load to an acceptable level.

All crane operators are certified and licensed per KMI 6430.4 Examination and Licensing of KSC Facility Crane Operators. Annual physicals for crane operators

KSC HAZARD REPORT printed 04/01/93 08:52:34 Contractor: LSOC page 4

HAZARD NUMBER: RT-ENG-1019 DATE IDENTIFIED: 04/05/88
STATUS (O/C): C MASTER # K-SPC-00355-I-CR TEAM: RT LOG # 19TITLE: PERSONNEL WORKING UNDER SUSPENDED LOAD FOR SRB PROCESSING (RPSF/VAB),
ORBITER STACKING (VAB), SSME MAINTENANCE (VAB/PAD), AND MDD (SLF/CLS/KSC)

ELIMINATION/CONTROL/ACCEPTED RISK RATIONALE: (Cont'd)

are required. To further minimize these hazards, only the personnel absolutely necessary to perform the operation are allowed to work near or under the suspended load.

All operations at KSC, with regard to working under a suspended load, are under "STATIC CONDITIONS" only. In no case is a load moved over personnel.

VERIFICATION METHODS:

The following OMIs contain steps and/or cautions to alert personel of the hazard and the requirement to minimize time under the suspended load:

RPSF

OMI NUMBER TASK/OPERATION

B5308	Cleaning of segment tang/capture feature for inspections
B5308	Cleaning of Aft end SRM insulation and J-Joint surfaces for inspections
B5308	Inspection of tang/capture feature (visual)
B5308	Inspection of SRM Aft end insulation, propellant relief flap and J-Joint surfaces (visual)
B5308	Air load/fiber optic video inspection of the capture feature-to-insulation bondline
B5308	Ultrasonic inspection of the insulation bondline behind the capture feature barrier O-ring groove
B5308	Installation/removal of protective pie-shapes over forward insulation and propellant surfaces of SRM while handling ring/end cover assembly is suspended above
B5308	Mating of Aft skirt to RPSF build-up stand support post ball fittings (cleaning surfaces)
B5308	Installation of protective velostat sheeting on tang aft surfaces
B5308	Inspection of SRM leak ports
B5308	Application of grease to bare metal surfaces of tang/capture feature
B5309	Cleaning of SRM Aft segment tang
B5309	Inspection of SRM Aft segment tang and crotch
B5309	Application of grease to Aft segment tang
B5309	Positioning of external tank attach (ETA) Ring on Aft segment stubs
B5309	Installation/removal of protective pie-shapes over forward insulation and propellant surfaces of SRM while handling ring/end cover assembly is suspended above
B5309	Mating of Aft skirt to SRM transportation pallet support post ball fittings.

KSC HAZARD REPORT printed 04/01/93 08:52:37 Contractor: LSOC page 5

HAZARD NUMBER: RT-ENG-1019 DATE IDENTIFIED: 04/05/88
STATUS (O/C): C MASTER # K-SPC-00355-I-CR TEAM: RT LOG # 19TITLE: PERSONNEL WORKING UNDER SUSPENDED LOAD FOR SRB PROCESSING (RPSF/VAB),
ORBITER STACKING (VAB), SSME MAINTENANCE (VAB/PAD), AND MDD (SLF/CLS/KSC)

VERIFICATION METHODS: (Cont'd)

B5309 Installation of O-ring prior to segment mate. (Segment
suspended 3' above another segment. Technicians hands/arms
under suspended load).

VAB

(B5303 Repairs of defects on SRM insulation, J-Joint, or metal parts in
work) (SRM or FWD ASSY) - not used for STS-26R.

B5303 Cleaning Aft skirt shoes and HDP bearings prior to set down of
Aft booster assembly on MLP

B5303 Connection of GEI umbilical plate to bottom of Aft skirt prior
to set down of Aft booster assembly on MLP

B5303 Reshimming of HDP Spherical bearings to meet HDP load
distribution requirements

B5303 Sighting of HDP Spherical bearing DELTA scales during reshimming
operation

B5303 Cleaning of segment tang/capture feature for inspections

B5303 Cleaning of Aft end SRM insulation and J-Joint surfaces for
inspections

B5303 Inspection of tang/capture feature (visual)

B5303 Inspection of SRM Aft end insulation, propellant relief flap and
J-Joint surfaces (visual)

B5303 Air load/fiber optic video inspection of the capture
feature-to-insulation bondline

B5303 Ultrasonic inspection of the insulation bondline behind the
capture feature barrier O-ring groove

B5303 SRM tang J-Joint and relief flap profile measurements

B5303 V-2 volume filler installation in tang capture feature

B5303 O-ring and barrier seal installation during field joint mating

B5303 J-Seal abrading

B5303 J-Joint adhesive application

B5303 Final joint closeout inspection

B5303 Field joint assembly fixture (FJAF) installation

B5303 Field joint mating process

B5303 Forward assembly clevis cleaning

B5303 Forward assembly clevis inspection

B5303 Forward assembly clevis grease application

B5303 O-ring groove inspection

T-5149 ET OFFLOAD MOVE AND SECURE IN C/O CELL

ET transporter is driven out from under external tank

KSC HAZARD REPORT printed 04/01/93 08:52:40 Contractor: LSOC page 6

HAZARD NUMBER: RT-ENG-1019 DATE IDENTIFIED: 04/05/88
STATUS (O/C): C MASTER # K-SPC-00355-I-CR TEAM: RT LOG # 19TITLE: PERSONNEL WORKING UNDER SUSPENDED LOAD FOR SRB PROCESSING (RPSF/VAB),
ORBITER STACKING (VAB), SSME MAINTENANCE (VAB/PAD), AND MDD (SLF/CLS/KSC)

VERIFICATION METHODS: (Cont'd)

(technicians steer transporter).

Disconnect Aft hardpoint- (2 persons under external tank raised
slightly off transporter)

VAB ORBITER HANDLING/HOISTING

- S0004 Slowly raise both 175-ton and 250-ton cranes until Orbiter main
gear clears floor 6 inches +/- 4 inches.
- S0004 Remove safety pin (G070-502453) from Nose Landing Gear Door and
Ground Pin (GW70-500696-002) from Nose Landing Gear Lock Brace
Assembly.
- S0004 Remove safety pin (G070-502461-001) from left main gear door and
Ground Pin (GW70-500696-003) from left main gear.
- S0004 Remove safety pin (G070-502461-001) from right gear door and
Ground Pin from the right main gear.
- S0004 Inspect tile on and around landing gear doors.

SSME LRU COMPONENT INSTALLATION/REMOVAL IN VAB - LOW BAY

- V5E06 Lifting operations in SSME area to remove/install SSME turbo
pump.

ORBITER AND SCA MATE/DEMATE

- S5022 Orbiter SCA mate/demate at DFRF/KSC
- S5044 Orbiter SCA mate/demate at contingency landing sites.
- V9005VL1 Hydraulic standard power up/power down for raising/lowering
landing gear.
- V5011 OMS POD removal/installation in the OPF.
Q3199

REMARKS/COMMENTS: (INCLUDE BACKGROUND, STATUS OF OPEN WORK, INTERFACES
WITH FLIGHT HARDWARE, OTHER CENTERS, ETC...)

REMARKS:

6/22/88 - SSRP changed to Industrial. This HR was neither approved nor
disapproved with CR 50404N, but left to KSC to control as an Industrial hazard.

KSC HAZARD REPORT printed 04/01/93 08:52:44 Contractor: LSOC page 7

HAZARD NUMBER: RT-ENG-1019 DATE IDENTIFIED: 04/05/88
STATUS (O/C): C MASTER # K-SPC-00355-I-CR TEAM: RT LOG # 19TITLE: PERSONNEL WORKING UNDER SUSPENDED LOAD FOR SRB PROCESSING (RPSF/VAB),
ORBITER STACKING (VAB), SSME MAINTENANCE (VAB/PAD), AND MDD (SLF/CLS/KSC)

REMARKS/COMMENTS: (Cont'd)

This hazard will be maintained in the KSC Hazard Data Base. Status changed to closed. "Damage to flight hardware" deleted from hazard effect data element.

2/17/89 - Added O-ring inspectoscope operation and references to cranes and OMIs used for Orbiter/SCA mate/demate at DFRF/KSC/CLS. Also added reference to hazard report RT-ENG-1027, which covers the 250-ton VAB crane single failure points.

BACKGROUND:

The Occupational Safety and Health Administration (OSHA) has stated that OSHA will not issue waivers to authorize the exposure of employees working beneath suspended loads. OSHA also states that any work procedures requiring such exposure are done so at the risk of the employer. The following reduces this risk to an acceptable level:

- a. All GSE developed for processing and inspection is designed to preclude the exposure of employees under suspended loads where ever possible.
- b. All inspection techniques are developed with proper inspection tools that would eliminate inspection procedures under suspended loads where ever possible.
- c. In those cases where it is not feasible to eliminate employee exposure working under a suspended load, an appropriate risk assessment must be made to assure the controls employed and the risk acceptance rationale is approved by management.

OPEN WORK:

The current Operations and Maintenance Requirements Specifications (OMRS) for the 200-ton crane in the RPSF and the 250-ton crane in the VAB are 79K27158 and 79K16835. These documents are currently under review and the requirements for the OMRS File VI are being prepared.

KSC HAZARD REPORT printed 04/02/93 12:33:09 Contractor: LSOC

HAZARD NUMBER: V-FAC-GEN-HR-08

DATE IDENTIFIED: 06/07/88

STATUS (O/C): C MASTER # K-POC-00000-P-CR

TEAM: PGOC LOG # 44

TITLE: LOSS OF PERSONNEL/FLIGHT HARDWARE DURING LIFTING OPERATIONS

RESP. ORGANIZATION: MDSSC/SRQA

LOCATION/STATION SETS: 19, 20, 23, CL, HS, K3, KP, OC, OS, SE, WB

BASELINES:

PROGRAM MODEL NOS.:

EFFECTIVITY/MISSION: 28+

EQUIPMENT CATEGORY: F A-SHUTTLE HARDWARE C-SHUTTLE/GSE E-SUPPORT EQUIP.
B-PAYLOAD HARDWARE D-PAYLOAD/GSE F-FACILITY/SITE

RESOLUTION DOC.-- (ESR, EO, INC., OMI, OMRSD FILE 6, OTHER)

CR NUMBER: PAYLOAD

FMEA/CIL:

TITLE:

OMRSD NUMBER:

TITLE:

OMI NUMBERS: E5501, E5510, E5531

ESRS:

OTHER:

TYPE OF HAZARD: B A-DESIGN B-OPERATIONAL C-OTHER

TYPE OF ANALYSIS: D A-PRELIMINARY B-SUBSYSTEM C-SYSTEM D-OPERATING&SUPP.

HAZARD CLOSURE CLASS.: C E-ELIMINATED C-CONTROLLED A-ACCEPTED RISK

HAZARD LEVEL: CN CA-CATASTROPHIC CR-CRITICAL CN-CONTROLLED

HAZARD GROUP: I SEVERITY: C_s PROBABILITY: A₀

PREPARED BY: C A-SPC B-BOC C-PGOC D-Other

SAFETY ENGINEER: T. MCARDLE

DATE: 06/14/88

CONTRACTOR MGMT. APPROVAL(1): WENDY DANKOVCHIK

DATE: 06/23/89

CONTRACTOR MGMT. APPROVAL(2): L. BONENFANT

DATE: 06/26/89

NASA APPROVALS(1): J. ROBERT LANG

DATE: 07/07/89

NASA APPROVALS(2): J. A. THOMAS

DATE: 07/12/89

DATE APPROVED: CCB: 11/17/89 SSRP: / / PRCB: / /

FUNCTION KEY: P S-NSTS/SHUTTLE I-INDUSTRIAL P-PAYLOAD
A-ADMINISTRATIVE O-OTHER CENTER/CONTRACTOR

SC Computerized 6-32

KSC HAZARD REPORT printed 04/02/93 12:33:10 Contractor: LSOC page 1

HAZARD NUMBER: V-FAC-GEN-HR-08 DATE IDENTIFIED: 06/07/88
STATUS (O/C): C MASTER # K-POC-00000-P-CR TEAM: PGOC LOG # 44

TITLE: LOSS OF PERSONNEL/FLIGHT HARDWARE DURING LIFTING OPERATIONS

HAZARD DESCRIPTION:

Personnel injury or death and/or payload/equipment damage or loss due to dropping the load or collision with structure(s) during payload handling operations.

HAZARD CAUSE(S):

Use of improper/faulty equipment; failure of crane hook; failure of support equipment (slings, shackles, pins); improper rigging; improper operation of lifting equipment; failure of crane brake; load striking facility structures.

HAZARD EFFECT(S):

Personnel injury/death and/or damage to facility, payload, and GSE.

ENGINEERING/SAFETY REQUIREMENTS:

NSS/GO 1740.9 - NASA Safety Standard for Lifting Devices and Equipment.

ELIMINATION/CONTROL/ACCEPTED RISK RATIONALE:

Requirements for inspection, maintenance, proof testing, and certification of cranes and lifting equipment shall be in accordance with NSS/GO 1740.9, "NASA Safety Standard for Lifting Devices and Equipment."

A proofload test at 1.25 times the rated load and an operational test shall be performed on all new or extensively repaired, extensively modified, or altered cranes and hoists.

Each crane shall undergo a rated load test and an operational test every four years. Critical cranes shall be load tested annually. Cranes used infrequently for critical lifts shall be load tested before the critical lift if it has been more than a year since the last test.

Daily and periodic inspections will be performed for all cranes. Cranes idle for more than one month shall be inspected prior to first use in accordance with NSS/GO-1740.9.

Daily inspections include: a check of functional operating and control mechanisms for maladjustments, excessive wear and contamination; a visual inspection of fluid system components for deterioration and leaks; and a visual inspection of the crane components (e.g., hook, ropes, etc.) for damage or excessive wear.

Periodic inspections per NSS/GO-1740.9 include inspections for: worn, cracked, deformed, corroded, or contaminated crane components (use of nondestructive evaluation to be utilized as needed or required by NSS/GO-1740.9); worn brake and clutch system components; and abnormal performance/malfunction of power plant(s), safety devices, load/other indicators, brakes, steering, and locking devices.

KSC HAZARD REPORT printed 04/02/93 12:33:11 Contractor: LSOC page 2

HAZARD NUMBER: V-FAC-GEN-HR-08 DATE IDENTIFIED: 06/07/88
STATUS (O/C): C MASTER # K-POC-00000-P-CR TEAM: PGOC LOG # 44

TITLE: LOSS OF PERSONNEL/FLIGHT HARDWARE DURING LIFTING OPERATIONS

ELIMINATION/CONTROL/ACCEPTED RISK RATIONALE: (Cont'd)

Lifting equipment shall be verified to be within valid proofload certification prior to use.

Operational checks will be performed prior to lifting operations to assure proper control response in all modes.

Cranes are operated only by trained and certified operators per KMI 6430.4, Examination and Licensing of KSC Facility Crane Operators, or KMI 6730.3, Examination and Licensing of KSC Special or Heavy Equipment Operators. Crane operators are required to carry a valid operators license with them at all times while operating a crane.

A pre-test briefing shall be held prior to the operation and personnel will be advised of their specific tasks and hazards involved.

Taglines shall be used during lifting operations to steady the load.

A controlled area shall be established for all lifting operations, and all nonessential personnel will be cleared from the control area.

Cranes will be operated only in the slow speed when in close proximity to structures or the floor.

MDSSC Safety shall monitor all hazardous lifting operations and their concurrence will be obtained prior to lifting.

Anytime an anomaly is observed, the operator will press the stop button to secure the load. The anomaly will be corrected before continuing operations.

Communications will be maintained between the crane controller and task leader or his designee during all hoisting operations. The crane controller will stop crane movement if communications are lost. Any person participating in an operation can call a stop to the operation if it is apparent that to continue would expose personnel or property to a dangerous or unacceptable risk.

MDSSC Safety Representative will obtain KSC Safety concurrence prior to hazardous operations.

VERIFICATION METHODS:

OMI L5130, Multi-Purpose Hoisting.
OMI E5516, GSE Handling, VPF.
OMI E55XX.

REMARKS/COMMENTS: (INCLUDE BACKGROUND, STATUS OF OPEN WORK, INTERFACES
WITH FLIGHT HARDWARE, OTHER CENTERS, ETC...)

REMARKS:

KSC HAZARD REPORT printed 04/02/93 12:33:13 Contractor: LSOC page 3

HAZARD NUMBER: V-FAC-GEN-HR-08

DATE IDENTIFIED: 06/07/88

STATUS (O/C): C MASTER # K-POC-00000-P-CR

TEAM: PGOC LOG # 44

TITLE: LOSS OF PERSONNEL/FLIGHT HARDWARE DURING LIFTING OPERATIONS

REMARKS/COMMENTS: (Cont'd)

LOCATION/STATION SETS

=====

19 - Orbiter Processing Facility
20 - Vehicle Assembly Building
23 - Launch Complex 39 Pads
K3 - Multi-Mission Support Equipment
CL - Payload Hazardous Servicing Building (PHSF)
HS - SAEF-2
KP - ESA-60 Dynamic Balance Lab
OC - O & C Building
OS - Ordnance Storage (RTG Facility)
SE - Payload Spin Test Facility
WB - Vertical Processing Facility

The following hazard reports have been incorporated and are superseded by this hazard report:

HAZARD REPORT NUMBER

SH-SL-GSE-006 (P02/16)	SH-SL-MOD-023 (P02/44)
34-02-000-89	SH-SL-MOD-022 (P02/43)
SH-SL-GSE-030	SH-SL-MOD-017 (P02/39)
SH-SL-IPS-001 (P02/57)	SH-SL-MOD-005 (P02/30)
SH-SL-PAL-001 (P02/51)	SF-OHA-SL3-42 (P16/21)
SH-SL-PAL-003 (P02/53)	SH-SL-IGL-002 (P02/56)
SH-SL-PAL-005	SH-SL-GEN-001 (P02/11)
SH-SL-MOD-001 (P02/26)	SH-SL-GSE-034 (P02/25)
34-02-SL1-087 (P02/74)	SH-SL-GSE-031 (P02/24)
34-02-SL1-090 (P02/76)	34-02-SL1-093 (P02/78)
34-02-SL1-094 (P02/79)	SH-SL-GSE-027 (P02/22)
SH-SL-GSE-033 (HOLD/99)	SH-SL-PAL-002 (P02/52)
SAA09VE04-018 H02 (P02/94)	34-02-SL1-089 (P02/75)

INTERFACES:

The hazards and controls noted by this hazard report have been identified for the following equipment:

O&C CRANES:	VPF CRANES:	PHSF CRANES:	ESA-60 CRANES:
(3) 27 1/2-Ton	(1) 2-Ton	(1) 50-Ton	(1) 5-Ton
(1) 2-Ton	(1) 25-Ton	(1) 15-Ton	(1) 10-Ton

KSC HAZARD REPORT printed 04/02/93 12:33:15 Contractor: LSOC page 4

HAZARD NUMBER: V-FAC-GEN-HR-08 DATE IDENTIFIED: 06/07/88
STATUS (O/C): C MASTER # K-POC-00000-P-CR TEAM: PGOC LOG # 44

TITLE: LOSS OF PERSONNEL/FLIGHT HARDWARE DURING LIFTING OPERATIONS

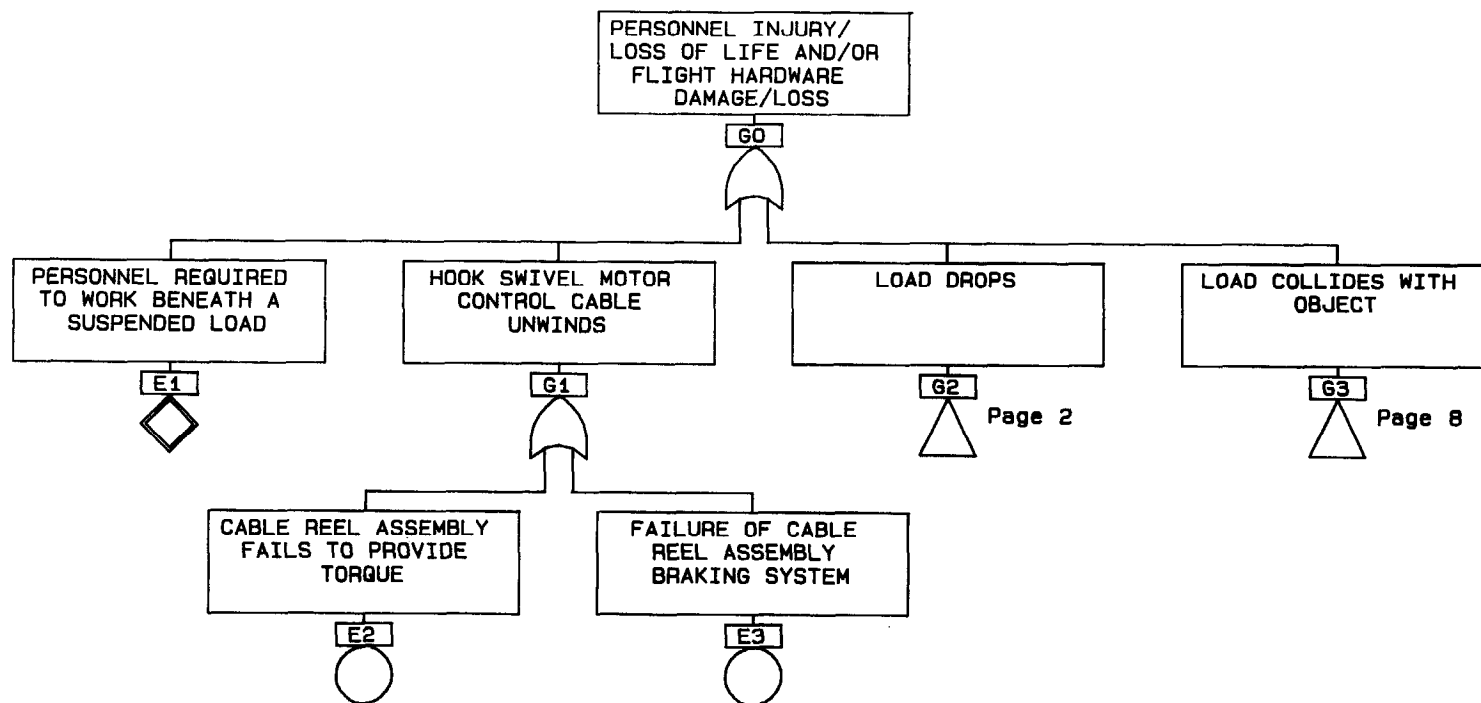
REMARKS/COMMENTS: (Cont'd)

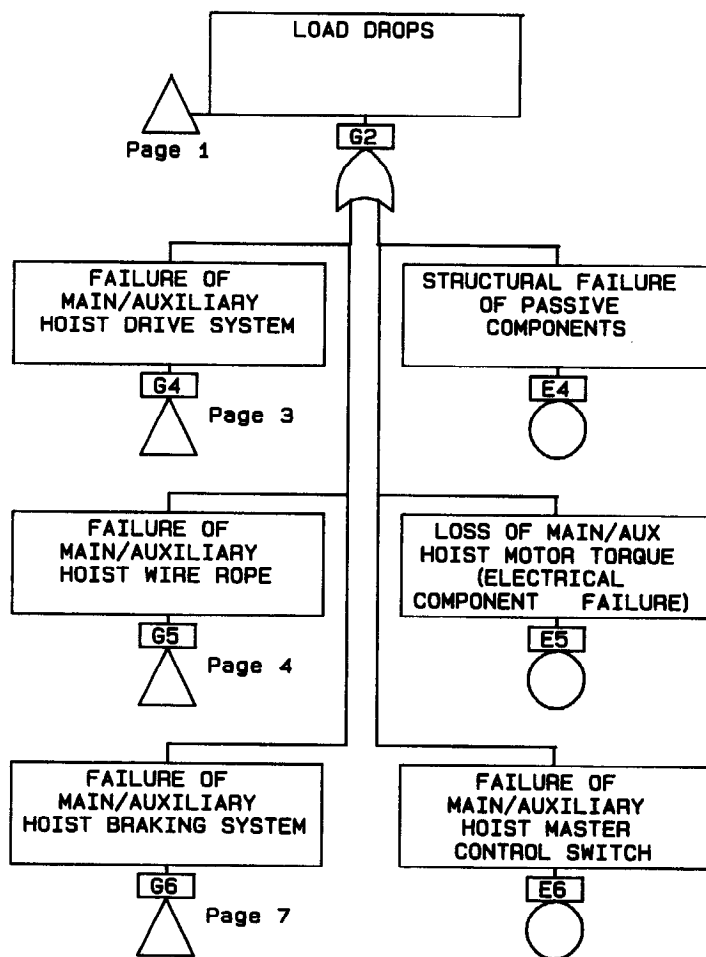
(1) 4-Ton (1) 12-Ton
(1) 10-Ton

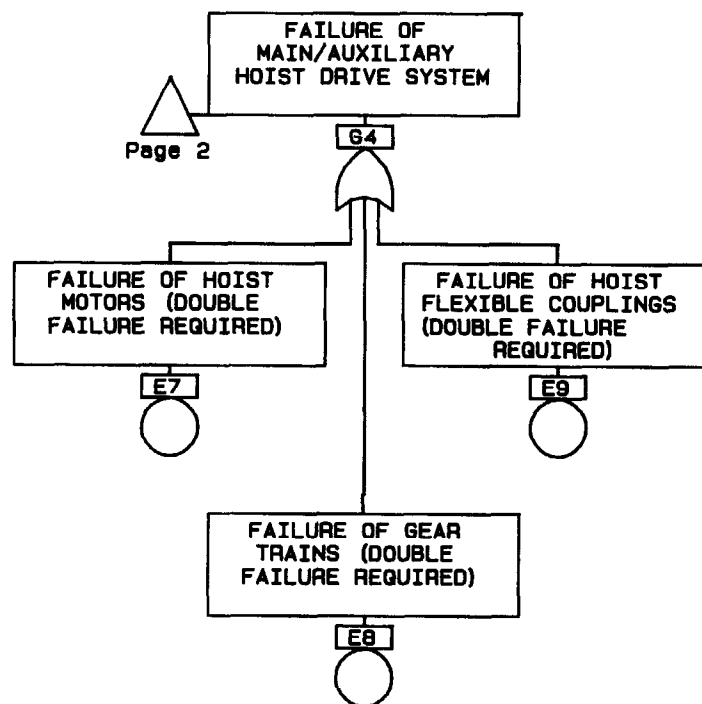
VAB CRANES:	SAEF II CRANES:	OPF CRANES:	RTG CRANE:
(2) 250/25-Ton	(1) 20-Ton	(2) 30-Ton, Bay 1	(1) 10-Ton
(1) 175-Ton	(2) 10-Ton	(2) 30-Ton, Bay 2	
(1) 125-Ton			

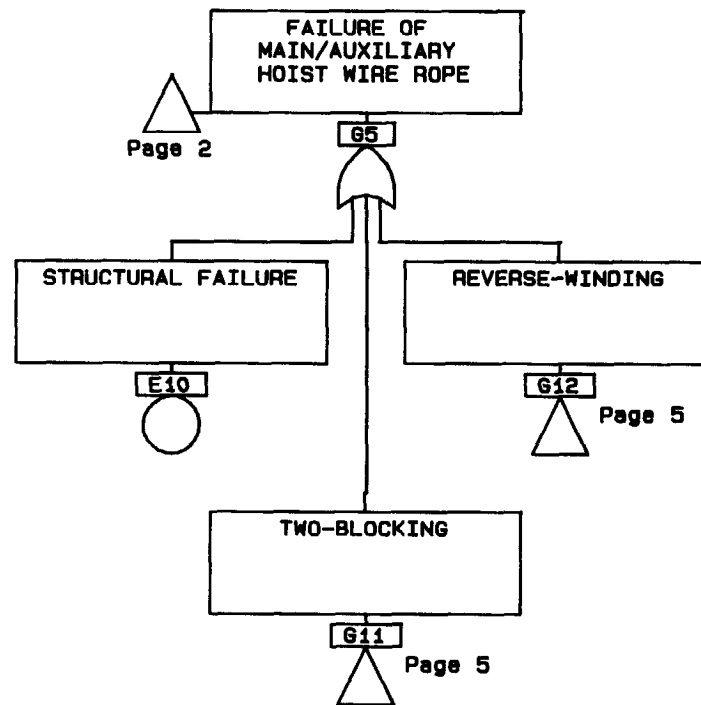
7.4 FAULT TREE ANALYSIS

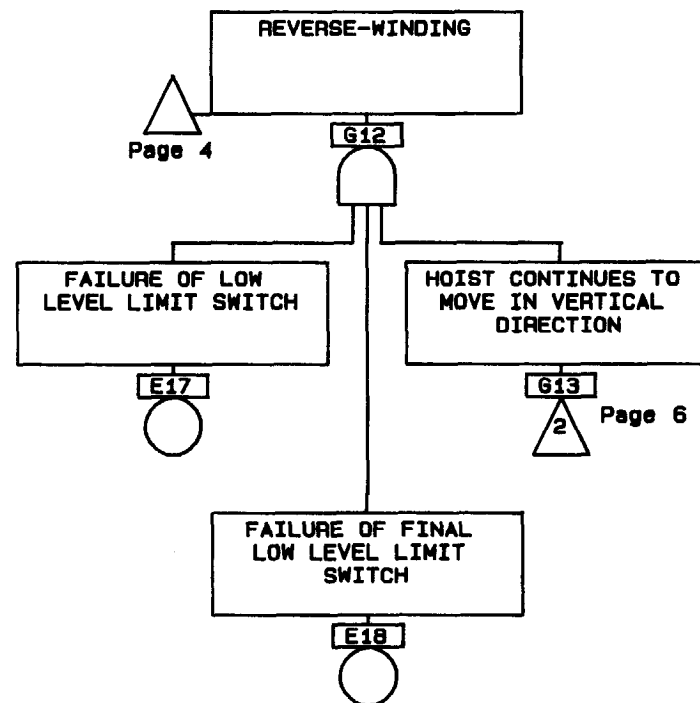
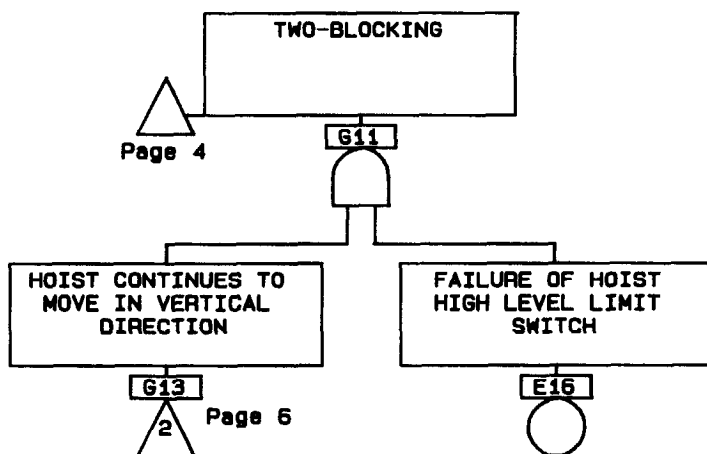
A qualitative fault tree analysis was developed with the top event identified as "Personnel Injury/Loss of Life and/or Flight Hardware Damage/Loss". Potential hazardous conditions leading to the top event have been assessed on the Hazard Analysis Worksheets located in Section 7.5.

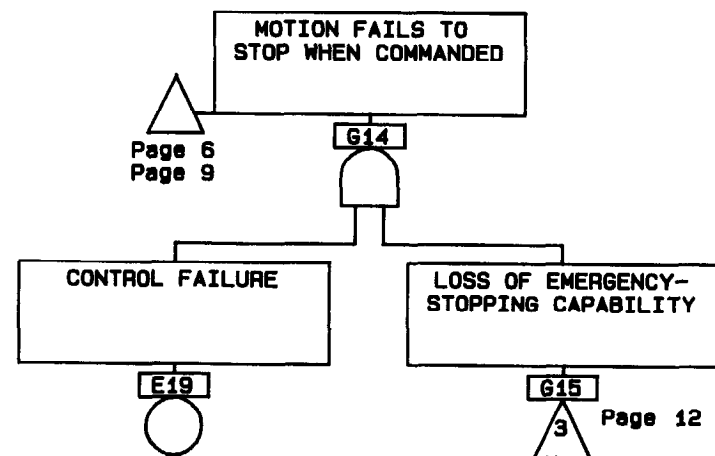
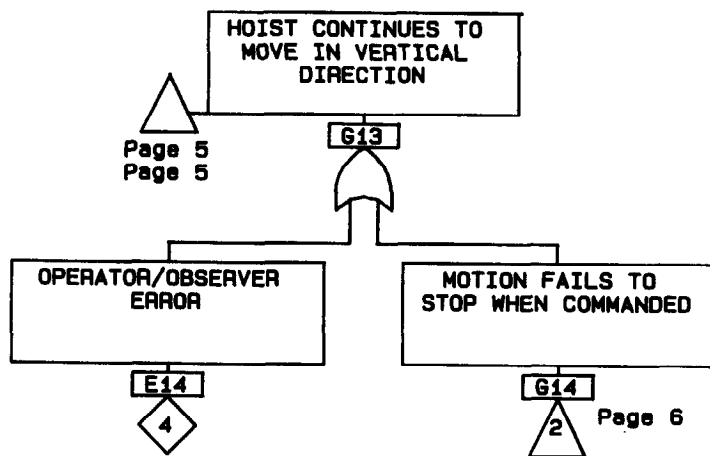


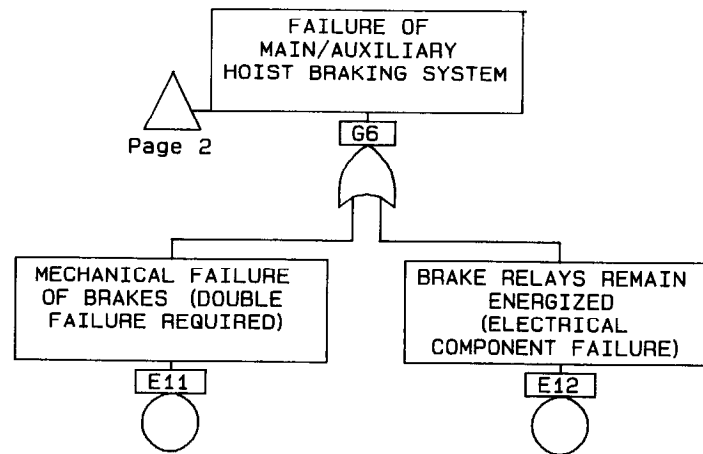


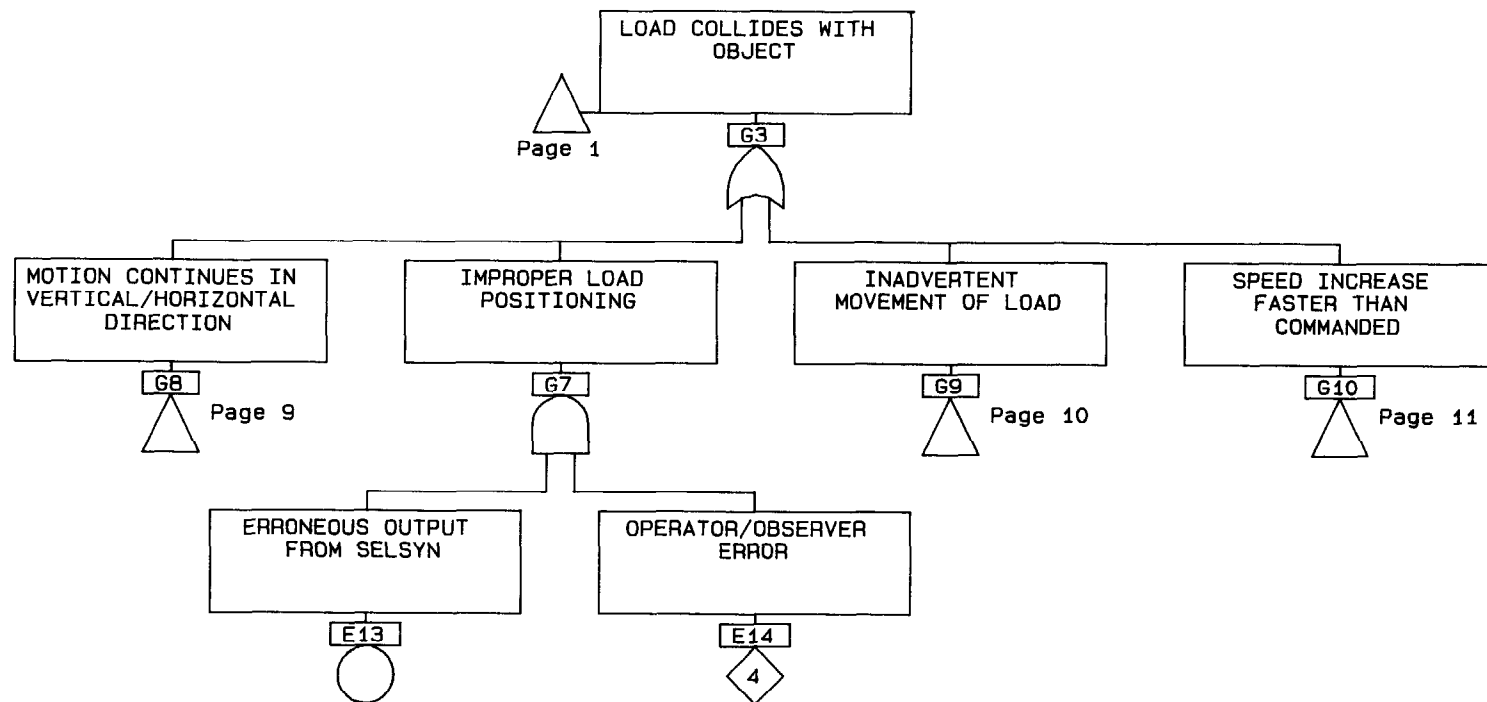


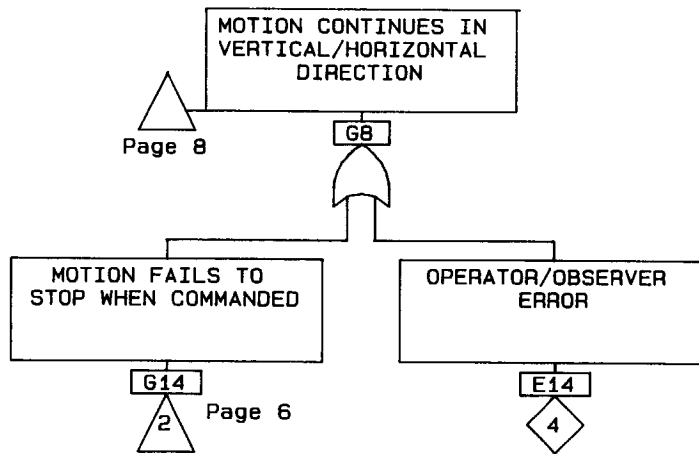


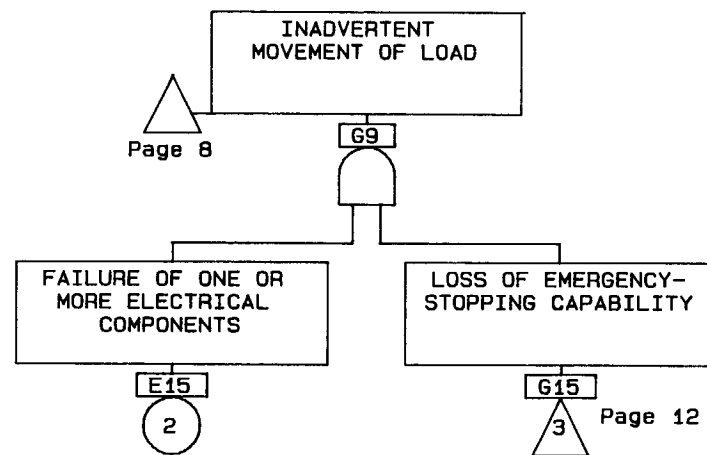


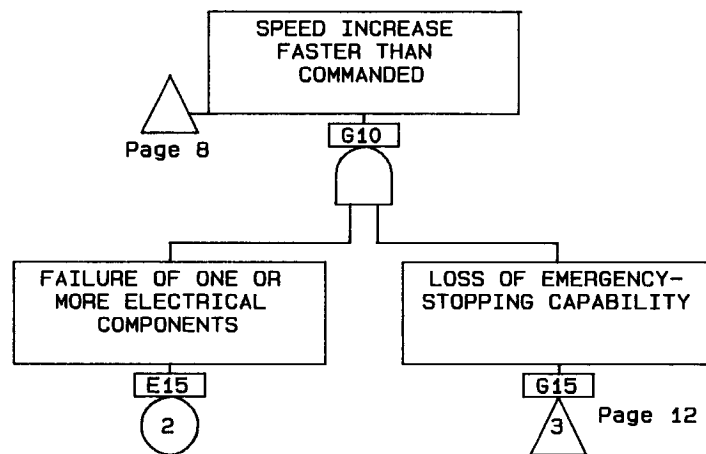


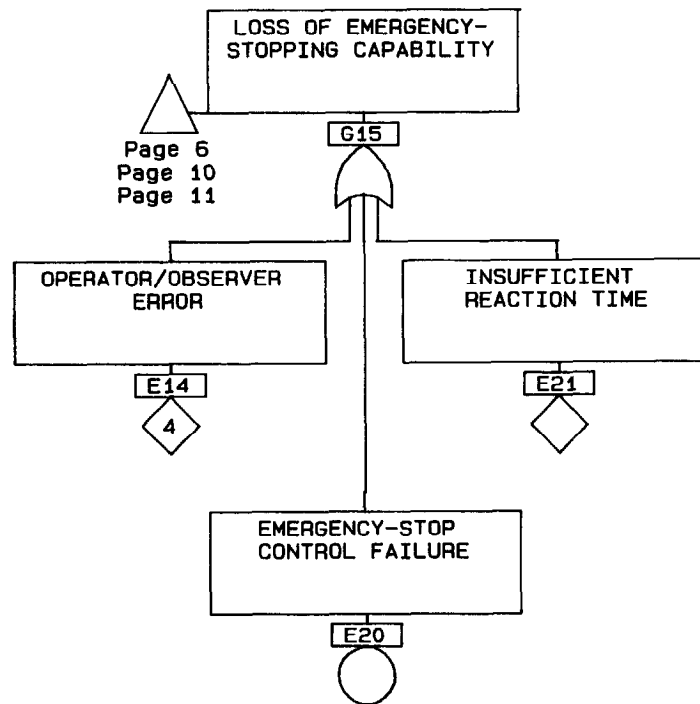












7.5 HAZARD ANALYSIS WORKSHEETS

The Hazard Analysis Worksheets were prepared in conjunction with the fault tree analysis depicting the specific hazardous conditions, causes, effects, safety/engineering requirements, and hazard elimination/control provisions. Worksheets are attached.

Table 64 (Page 1 of 11). HAZARD ANALYSIS WORKSHEETS				
Phase/Mode Function 175-TON BRIDGE CRANE			Date JULY 1993	
Task/Operation or Facility VAB			Prepared by J. GARRETT, LSOC 52-11	
HAZARDOUS CONDITION	HAZARD CAUSE	HAZARD EFFECT	SAFETY/ENGINEERING REQUIREMENTS	HAZARD ELIMINATION/CONTROL PROVISIONS
E1 PERSONNEL REQUIRED TO WORK BENEATH A SUSPENDED LOAD	E1 OPERATIONAL REQUIREMENTS	G0 PERSONNEL INJURY/LOSS OF LIFE	E1 29 CFR 1910.179(n)(3)(vii), THE EMPLOYER SHALL REQUIRE THAT THE OPERATOR AVOID CARRYING LOADS OVER PEOPLE. GP1098F, 2.36, A LOAD WILL NOT BE LIFTED, SUSPENDED OR TRANSPORTED OVER PERSONNEL. NSS/GO 1740.9B, 206a.(21), PERSONNEL SHALL NOT BE LOCATED UNDER SUSPENDED OR MOVING LOADS UNLESS THE OPERATION ADHERES TO THE OSHA-APPROVED NASA ALTERNATE STANDARD FOR SUSPENDED LOAD OPERATIONS.	E1 ONLY OPERATIONS APPROVED BY SUSPENDED LOAD OPERATION ANALYSIS/APPROVAL PREPARED PER NASA ALTERNATE STANDARD FOR SUSPENDED LOAD OPERATIONS ALLOW PERSONNEL UNDER A SUSPENDED LOAD. ONLY APPROVED NUMBER OF PERSONNEL ALLOWED UNDER A SUSPENDED LOAD FOR TIME REQUIRED TO ACCOMPLISH TASK. ONLY TRAINED AND CERTIFIED PERSONNEL MAY OPERATE CRANES. CRITICAL SKILLS VERIFIED PER OMI Q3008. PERIODIC MAINTENANCE AND INSPECTION PERFORMED INCLUDING MONTHLY OPERATIONAL CHECK PER OMI Q6003. OPERATIONAL CHECK PERFORMED PRIOR TO EACH LIFT PER OMI Q3008. REFERENCE HAZARD REPORT RT-ENG-1019.
G1 HOOK SWIVEL MOTOR CONTROL CABLE UNWINDS	E2 CABLE REEL ASSEMBLY FAILS TO PROVIDE TORQUE OR E3 FAILURE OF CABLE REEL ASSEMBLY BRAKING SYSTEM	G0 FLIGHT HARD- WARE DAMAGE	E2, E3 NSS/GO 1740.9B, 202c, OPERATIONAL TESTS REQUIRED; 203, PERIODIC INSPECTIONS REQUIRED; 204, PERIODIC MAINTENANCE REQUIRED. OMRSD FILE VI GTAFCRVD0.026 REQUIRES OPERATIONAL TESTS.	E2, E3 PERIODIC MAINTENANCE AND INSPECTION PERFORMED INCLUDING MONTHLY INSPECTION OF CABLE REEL ASSEMBLY, GEAR REDUCER OIL CHECK, AND OPERATION CHECK, SEMI-ANNUAL INSPECTION OF CABLE REEL MOTOR AND HOUSING; AND ANNUAL OIL SAMPLING OF CABLE REEL GEAR REDUCER, INSPECTION OF CABLE REEL MOTOR, BRAKE AND CHAIN DRIVE, INSPECTION OF IDLER PULLEY, AND INSPECTION OF CHAIN DRIVE FOR BINDING PER OMI Q6003. PREOPERATION INSPECTION OF CABLE REEL ASSEMBLY PERFORMED PER OMI Q3008. OPERATIONAL CHECK OF MAIN HOIST SYSTEM IS PERFORMED PRIOR TO LIFT PER OMI Q3008.

Table 64 (Page 2 of 11). HAZARD ANALYSIS WORKSHEETS				
Phase/Mode Function 175-TON BRIDGE CRANE			Date JULY 1993	
Task/Operation or Facility VAB			Prepared by J. GARRETT, LSOC 52-11	
HAZARDOUS CONDITION	HAZARD CAUSE	HAZARD EFFECT	SAFETY/ENGINEERING REQUIREMENTS	HAZARD ELIMINATION/CONTROL PROVISIONS
G2 LOAD DROPS	G4 FAILURE OF MAIN/AUXILIARY HOIST DRIVE SYSTEM	G0 PERSONNEL INJURY/LOSS OF LIFE AND/OR FLIGHT HARD- WARE DAMAGE/LOSS	DEVELOPED UNDER HAZARDOUS CONDITION G4.	DEVELOPED UNDER HAZARDOUS CONDITION G4.
	OR			
	G5 FAILURE OF MAIN/AUXILIARY HOIST WIRE ROPE		DEVELOPED UNDER HAZARDOUS CONDITION G5.	DEVELOPED UNDER HAZARDOUS CONDITION G5.
	OR			
	G6 FAILURE OF MAIN/AUXILIARY HOIST BRAKING SYSTEM		DEVELOPED UNDER HAZARDOUS CONDITION G6.	DEVELOPED UNDER HAZARDOUS CONDITION G6.
	OR			
	E4 STRUCTURAL FAILURE OF PASSIVE COM- PONENTS		E4 NSS/G0 1740.9B, 202, PROOF LOAD, RATED LOAD AND OPERATIONAL TESTS REQUIRED; 203, PERIODIC INSPECTION REQUIRED; 204, PERIODIC MAINTENANCE REQUIRED. OMRSD FILE VI GTAFCRVD0.002 REQUIRES ANNUAL LOAD TEST AT 100% OF RATED LOAD.	E4 PERIODIC INSPECTION AND MAINTENANCE INCLUDING MONTHLY WALKDOWN OF ENTIRE CRANE INSPECTING FOR DAMAGE CORROSION OR LOOSE HARDWARE, INSPECTION OF BRIDGE AND TROLLEY STRUCTURE, INSPECTION OF HOIST STRUCTURES INCLUDING DRUMS, INSPECTION OF HOOKS; SEMI-ANNUAL INSPECTION OF BRIDGE AND TROLLEY RUNWAYS AND WHEELS, HOIST DRUMS, LOAD BLOCKS AND SHEAVES; AND ANNUAL INSPECTION OF HOOK, HOOK TRUNION AND ANNUAL LOAD TEST AND HOOK MAGAFLUX PER OMI Q6003. PREOPERATIONAL CHECK AND INSPECTION PERFORMED PRIOR TO EACH LIFT. VERIFICATION OF ANNUAL LOAD TEST PER OMI Q3008.

Table 64 (Page 3 of 11). HAZARD ANALYSIS WORKSHEETS				
Phase/Mode Function 175-TON BRIDGE CRANE			Date JULY 1993	
Task/Operation or Facility VAB			Prepared by J. GARRETT, LSOC 52-11	
HAZARDOUS CONDITION	HAZARD CAUSE	HAZARD EFFECT	SAFETY/ENGINEERING REQUIREMENTS	HAZARD ELIMINATION/CONTROL PROVISIONS
G4 FAILURE OF MAIN/AUXILIARY HOIST DRIVE SYSTEM	OR E5 LOSS OF MAIN/AUX HOIST MOTOR TORQUE	G2 LOAD DROPS	E5 NSS/GO 1740.9B, 201g.(6), ELECTRICAL SYSTEMS SHALL BE DESIGNED FAILSAFE; 202c, OPERATIONAL TESTS REQUIRED; 203, PERIODIC INSPECTION REQUIRED; 204, PERIODIC MAINTENANCE REQUIRED. OMRSD FILE VI GTAFCRVD0.026 REQUIRES OPERATIONAL TEST. OMRSD FILE VI GTAFCRVD0.027 REQUIRES AMMETER S/O POINT.	E5 PERIODIC MAINTENANCE AND INSPECTION PERFORMED INCLUDING MONTHLY OPERATIONAL TEST; SEMIANNUAL INSPECTION OF ELECTRICAL ROTATING MACHINERY, COMMUTATORS AND INSULATION RESISTANCE CHECK; AND ANNUAL INSPECTION OF CONTACTS AND CONTACT MEMBERS, ELECTRICAL WIRING, RESISTORS, SELSYNS AND POWER FEEDRAILS PER OMI Q6003. OPERATIONAL TEST PERFORMED PRIOR TO OPERATIONS PER OMI Q3008.
	OR E6 FAILURE OF MAIN/AUXILIARY HOIST MASTER CONTROL SWITCH		E6 NSS/GO 1740.9B, 201g.(6), ELECTRICAL SYSTEMS SHALL BE DESIGNED FAILSAFE; 202c, OPERATIONAL TESTS REQUIRED; 203, PERIODIC INSPECTION REQUIRED; 204, PERIODIC MAINTENANCE REQUIRED. OMRSD FILE VI GTAFCRVD0.026 REQUIRES OPERATIONAL TEST. OMRSD FILE VI GTAFCRVD0.027 REQUIRES AMMETER S/O POINT.	E6 PERIODIC MAINTENANCE AND INSPECTION PERFORMED INCLUDING MONTHLY OPERATIONAL TEST; SEMIANNUAL INSPECTION OF ELECTRICAL ROTATING MACHINERY, COMMUTATORS AND INSULATION RESISTANCE CHECK; AND ANNUAL INSPECTION OF CONTACTS AND CONTACT MEMBERS, ELECTRICAL WIRING, RESISTORS, SELSYNS AND POWER FEEDRAILS PER OMI Q6003. OPERATIONAL TEST PERFORMED PRIOR TO OPERATIONS PER OMI Q3008.
	E7 FAILURE OF HOIST MOTORS (DOUBLE FAILURE REQUIRED)		E7 NSS/GO 1740.9B, 202c, OPERATIONAL TESTS REQUIRED; 203, PERIODIC INSPECTION REQUIRED; 204, PERIODIC MAINTENANCE REQUIRED. OMRSD FILE VI GTAFCRVD0.026 REQUIRES OPERATIONAL TEST.	E7 DOUBLE FAILURE REQUIRED. PERIODIC MAINTENANCE AND INSPECTION INCLUDES MONTHLY OPERATIONAL TEST; AND SEMIANNUAL INSPECTION OF MOTORS PER OMI Q6003. OPERATIONAL TEST PERFORMED PRIOR TO LIFT PER OMI Q3008.

Table 64 (Page 4 of 11). HAZARD ANALYSIS WORKSHEETS				
Phase/Mode Function 175-TON BRIDGE CRANE			Date JULY 1993	
Task/Operation or Facility VAB			Prepared by J. GARRETT, LSOC 52-11	
HAZARDOUS CONDITION	HAZARD CAUSE	HAZARD EFFECT	SAFETY/ENGINEERING REQUIREMENTS	HAZARD ELIMINATION/CONTROL PROVISIONS
G5 FAILURE OF MAIN/AUXILIARY HOIST WIRE ROPE	<p>OR</p> <p>E8 FAILURE OF GEAR TRAINS (DOUBLE FAILURE REQUIRED)</p>	G2 LOAD DROPS	<p>E8 NSS/GO 1740.9B, 201f.(c), GEARING SHALL BE DESIGNED PER AGMA STANDARDS; 202, PROOF LOAD, RATED LOAD AND OPERATIONAL TESTS REQUIRED; 203, PERIODIC INSPECTIONS REQUIRED; 204, PERIODIC MAINTENANCE REQUIRED.</p> <p>OMRSD FILE VI GTAFCRVD0.002 REQUIRES ANNUAL LOAD TEST AT 100% RATED LOAD.</p> <p>OMRSD FILE VI GTAFCRVD0.026 REQUIRES OPERATIONAL TEST.</p>	<p>E8 DOUBLE FAILURE REQUIRED. EACH GEAR TRAIN CAPABLE OF HOLDING THE RATED LOAD.</p> <p>PERIODIC INSPECTION AND MAINTENANCE INCLUDES MONTHLY INSPECTION OF HOIST GEAR REDUCERS AND OPERATIONAL CHECK; SEMIANNUAL INSPECTION OF HOIST DRUM GEARS AND PINIONS FOR DAMAGE, CORRECT MESHING AND LUBRICATION; AND ANNUAL OIL SAMPLING AND LOAD TEST PER OMI Q6003.</p> <p>PREOPERATIONAL CHECK PERFORMED PRIOR TO LIFT PER OMI Q3008.</p>
	<p>OR</p> <p>E9 FAILURE OF HOIST FLEXIBLE COUPLINGS (DOUBLE FAILURE REQUIRED)</p>		<p>E9 NSS/GO 1740.9B, 202, PROOF LOAD, RATED LOAD AND OPERATIONAL TESTS REQUIRED; 203, PERIODIC INSPECTIONS REQUIRED; 204, PERIODIC MAINTENANCE REQUIRED.</p> <p>OMRSD FILE VI GTAFCRVD0.002 REQUIRES ANNUAL LOAD TEST AT 100% RATED LOAD.</p> <p>OMRSD FILE VI GTAFCRVD0.026 REQUIRES OPERATIONAL TEST.</p>	<p>E9 DOUBLE FAILURE REQUIRED. EACH COUPLING CAPABLE OF HOLDING THE RATED LOAD.</p> <p>PERIODIC INSPECTION AND MAINTENANCE INCLUDES MONTHLY INSPECTION AND OPERATIONAL CHECK; QUARTERLY INSPECTION OF DRIVE COUPLINGS FOR SECURITY ON SHAFTS AND FLANGE BOLTS OR SPRING RETAINERS DISPLACEMENT; AND ANNUAL LOAD TEST PER OMI Q6003.</p> <p>OPERATIONAL CHECK PERFORMED PRIOR TO LIFT PER OMI Q3008.</p>
	<p>G11 TWO-BLOCKING</p> <p>OR</p> <p>G12 REVERSE-WINDING</p>		<p>DEVELOPED UNDER HAZARDOUS CONDITION G11.</p> <p>DEVELOPED UNDER HAZARDOUS CONDITION G12.</p>	<p>DEVELOPED UNDER HAZARDOUS CONDITION G11.</p> <p>DEVELOPED UNDER HAZARDOUS CONDITION G12.</p>

Table 64 (Page 5 of 11). HAZARD ANALYSIS WORKSHEETS				
Phase/Mode Function 175-TON BRIDGE CRANE			Date JULY 1993	
Task/Operation or Facility VAB			Prepared by J. GARRETT, LSOC 52-11	
HAZARDOUS CONDITION	HAZARD CAUSE	HAZARD EFFECT	SAFETY/ENGINEERING REQUIREMENTS	HAZARD ELIMINATION/CONTROL PROVISIONS
G11 TWO-BLOCKING	OR E10 STRUCTURAL FAILURE	G5 FAILURE OF MAIN/AUXILIARY HOIST WIRE ROPE	E10 NSS/GO 1740.9B, 201f.(1), DESIGN REQUIREMENTS FOR WIRE ROPE; 202, PROOF LOAD, RATED LOAD AND OPERATIONAL TESTS REQUIRED; 203, PERIODIC INSPECTION REQUIRED; 204, PERIODIC MAINTENANCE REQUIRED. OMRSD FILE VI GTAFCDVD0.002 REQUIRES ANNUAL LOAD TEST AT 100% RATED LOAD. OMRSD FILE VI GTAFCDVD0.026 REQUIRES OPERATIONAL TEST.	E10 MAIN AND AUXILIARY HOISTS ARE PROVIDED WITH DUAL WIRE ROPES, EACH CAPABLE OF HOLDING THE RATED LOAD. PERIODIC MAINTENANCE AND INSPECTION PERFORMED INCLUDING MONTHLY INSPECTION OF WIRE ROPE FOR KINKS, CRIMPS, WEAR, BROKEN WIRES OR REDUCTION IN DIAMETER, INSPECTION OF ROPE TERMINATIONS AND ANNUAL LOAD TEST PER OMI Q6003. OPERATIONAL TEST PERFORMED PRIOR TO LIFT PER OMI Q3008.
	AND E16 FAILURE OF HOIST HIGH LEVEL LIMIT SWITCH.		DEVELOPED UNDER HAZARDOUS CONDITION G13.	DEVELOPED UNDER HAZARDOUS CONDITION G13.
G12 REVERSE-WINDING	G13 HOIST CONTINUES TO MOVE IN VERTICAL DIRECTION	G5 FAILURE OF MAIN/AUXILIARY HOIST WIRE ROPE	E16 NSS/GO 1740.9B, 201g.(9), CRANES USED FOR CRITICAL LIFT REQUIRE DUAL UPPER LIMIT SWITCHES; 202c, OPERATIONAL TEST REQUIRED; 204b(3), MAINTENANCE REQUIREMENTS FOR LIMIT SWITCHES. OMRSD FILE VI GTAFCDVD0.026 REQUIRES OPERATIONAL TEST.	E16 PERIODIC MAINTENANCE AND INSPECTION INCLUDES OPERATION OF LIMIT SWITCH AT BEGINNING OF EACH SHIFT DURING MONTHLY MAINTENANCE AND ANNUAL INSPECTION OF LIMIT SWITCHES AND OPERATIONAL CHECK DURING LOAD TEST PER OMI Q6003. OPERATORS ARE WARNED NOT TO USE LIMIT SWITCHES DURING HOISTING OPERATIONS TO STOP CRANE MOTION PER OMI Q3008. OPERATIONAL TEST OF LIMIT SWITCHES PRIOR TO LIFT PER OMI Q3008.
			DEVELOPED UNDER HAZARDOUS CONDITION G13.	DEVELOPED UNDER HAZARDOUS CONDITION G13.

Table 64 (Page 6 of 11). HAZARD ANALYSIS WORKSHEETS				
Phase/Mode Function 175-TON BRIDGE CRANE			Date JULY 1993	
Task/Operation or Facility VAB			Prepared by J. GARRETT, LSOC 52-11	
HAZARDOUS CONDITION	HAZARD CAUSE	HAZARD EFFECT	SAFETY/ENGINEERING REQUIREMENTS	HAZARD ELIMINATION/CONTROL PROVISIONS
G13 HOIST CONTINUES TO MOVE IN VERTICAL DIRECTION	AND E17 FAILURE OF LOW LEVEL LIMIT SWITCH		E17, E18 NSS/GO 1740.9B, 201g.(10), CRANES USED FOR CRITICAL LIFTS SHALL BE PROVIDED WITH LOWER LIMIT SWITCHES TO PREVENT REVERSE-WINDING OF THE WIRE ROPE; 202, OPERATIONAL TEST REQUIRED; 204b(3), MAINTENANCE REQUIREMENTS FOR LIMIT SWITCHES. OMRSD FILE VI GTAFCRVD0.026 REQUIRES OPERATIONAL TEST.	E17, E18 DOUBLE FAILURE REQUIRED. PERIODIC MAINTENANCE AND INSPECTION INCLUDES MONTHLY OPERATIONAL TEST OF LIMIT SWITCHES, ANNUAL INSPECTION OF LIMIT SWITCHES AND OPERATIONAL TEST UNDER NO LOAD PRIOR TO ANNUAL LOAD TEST PER OMI Q6003. OPERATORS ARE WARNED NOT TO USE LIMIT SWITCHES TO STOP CRANE MOTION PER OMI Q3008. OPERATIONAL TEST OF LIMIT SWITCHES PERFORMED PRIOR TO LIFTS PER OMI Q3008.
	AND E18 FAILURE OF FINAL LOW LEVEL LIMIT SWITCH			
	G14 MOTION FAILS TO STOP WHEN COMMANDED	G11 TWO-BLOCKING	DEVELOPED UNDER HAZARDOUS CONDITION G14.	DEVELOPED UNDER HAZARDOUS CONDITION G14.
	OR E14 OPERATOR/OBSERVER ERROR	AND G12 REVERSE-WINDING	E14 NSS/GO 1740.9B, 205a, ONLY CERTIFIED AND TRAINED OPERATORS SHALL USE/ OPERATE CRANES.	E14 CRITICAL SKILLS VERIFIED FOR CRANE OPERATORS AND OBSERVERS (CSR 019-1, 091-1, 094-1, 019-4, 091-4 AND 094-4) PRIOR TO OPERATIONS PER OMI Q3008. SUPPLEMENTARY OPERATOR INSTRUCTIONS GIVEN IN OMI Q3008, APPENDIX C. EMERGENCY INSTRUCTIONS GIVEN PER OMI Q3008, APPENDIX Z. COMMUNICATIONS CHECK PRIOR TO OPERATIONS PER OMI Q3008.

Table 64 (Page 7 of 11). HAZARD ANALYSIS WORKSHEETS				
Phase/Mode Function 175-TON BRIDGE CRANE			Date JULY 1993	
Task/Operation or Facility VAB			Prepared by J. GARRETT, LSOC 52-11	
HAZARDOUS CONDITION	HAZARD CAUSE	HAZARD EFFECT	SAFETY/ENGINEERING REQUIREMENTS	HAZARD ELIMINATION/CONTROL PROVISIONS
G14 MOTION FAILS TO STOP WHEN COMMANDED	G15 LOSS OF EMERGENCY-STOPPING CAPABILITY AND E19 CONTROL FAILURE	G13 HOIST CONTINUES TO MOVE IN VERTICAL DIRECTION AND G8 MOTION CONTINUES IN VERTICAL/HORIZONTAL DIRECTION	DEVELOPED UNDER HAZARDOUS CONDITION G15. E19 NSS/G0 1740.9B, 201g.(4), CONTROL LEVER SHALL BE USED FOR SPEED CONTROL. CONTROLS SHALL RETURN TO OFF POSITION WHEN OPERATOR RELIEVES PRESSURE; 201g.(5), ALL CAB-OPERATED CRANES WITH STEP TYPE CONTROL SHALL BE EQUIPPED WITH LEVER CONTROLS. CONTROLS SHALL BE OF CONTINUOUS EFFECT TYPE AND PROVIDED WITH DEAD MAN FEATURE THAT WILL NOT CAUSE OPERATOR FATIGUE; 202, OPERATIONAL TEST REQUIRED; 203, PERIODIC INSPECTIONS REQUIRED; 204b.(2), PERIODIC MAINTENANCE REQUIRED. OMRSD FILE VI GTAFCRVD0.026 REQUIRES OPERATIONAL TEST.	DEVELOPED UNDER HAZARDOUS CONDITION G15. E19 PERIODIC MAINTENANCE AND INSPECTION PERFORMED INCLUDING MONTHLY OPERATIONAL TEST PER OMI Q6003. PREOPERATION TEST PERFORMED PRIOR TO LIFT PER OMI Q3008. ALL OPERATIONS REQUIRE OBSERVERS WITH REMOTE EMERGENCY STOP POSITIONED IN VIEW OF LOAD. EMERGENCY PROCEDURES GIVEN PER OMI Q3008, APPENDIX Z.
G6 FAILURE OF MAIN/AUXILIARY HOIST BRAKING SYSTEM	E11 MECHANICAL FAILURE OF BRAKES (DOUBLE FAILURE REQUIRED)	G2 LOAD DROPS	E11, E12 NSS/G0 1740.9B, 201f.(2)(f), FOR CRITICAL LIFTS, TWO MEANS OF BRAKING SHALL BE PROVIDED, EACH CAPABLE OF BRINGING A RATED LOAD TO ZERO SPEED AND HOLDING IT; 202, PROOF LOAD, RATED LOAD AND OPERATIONAL TESTS REQUIRED; 203e.(d), PERIODIC INSPECTION REQUIRED; 204b.(1), PERIODIC MAINTENANCE REQUIRED. OMRSD FILE VI GTAFCRVD0.002 REQUIRES ANNUAL BRAKE LOAD TEST. OMRSD FILE VI GTAFCRVD0.026 REQUIRES OPERATIONAL TEST.	E11, E12 MAIN AND AUXILIARY HOISTS ARE EQUIPPED WITH DUAL BRAKES, EACH CAPABLE OF HOLDING THE RATED LOAD. PERIODIC MAINTENANCE AND INSPECTION PERFORMED INCLUDING MONTHLY OPERATIONAL TEST AND BRAKE INSPECTION; QUARTERLY BRAKE ADJUSTMENT; SEMIANNUAL INSPECTION OF BRAKE WHEELS; AND ANNUAL INSPECTION OF CONTACT AND CONTACT MEMBERS, AND ANNUAL BRAKE LOAD TEST PER OMI Q6003. OPERATIONAL TEST PERFORMED PRIOR TO EACH LIFT PER OMI Q3008.

Table 64 (Page 8 of 11). HAZARD ANALYSIS WORKSHEETS				
Phase/Mode Function 175-TON BRIDGE CRANE			Date JULY 1993	
Task/Operation or Facility VAB			Prepared by J. GARRETT, LSOC 52-11	
HAZARDOUS CONDITION	HAZARD CAUSE	HAZARD EFFECT	SAFETY/ENGINEERING REQUIREMENTS	HAZARD ELIMINATION/CONTROL PROVISIONS
G3 LOAD COLLIDES WITH OBJECT	OR E12 BRAKE RELAYS REMAIN ENER- GIZED (ELEC- TRICAL COMPONENT FAILURE)	G0 PERSONNEL INJURY/LOSS OF LIFE AND/OR FLIGHT HARD- WARE DAMAGE/LOSS	E12 NSS/GO 1740.9B, 201g.(6), ELECTRICAL SYSTEMS SHALL BE DESIGNED FAILSAFE; 202c, OPERATIONAL TESTS REQUIRED; 203, PERIODIC INSPECTION REQUIRED; 204, PERIODIC MAINTENANCE REQUIRED. OMRSD FILE VI GTAFCRVD0.026 REQUIRES OPERATIONAL TEST. OMRSD FILE VI GTAFCRVD0.027 REQUIRES AMMETER S/O POINT.	E12 PERIODIC MAINTENANCE AND INSPECTION PERFORMED INCLUDING MONTHLY OPERATIONAL TEST; SEMIANNUAL INSPECTION OF ELECTRICAL ROTATING MACHINERY, COMMUTATORS AND INSULATION RESISTANCE CHECK; AND ANNUAL INSPECTION OF CONTACTS AND CONTACT MEMBERS ELECTRICAL WIRING, RESISTORS, SELSYNS AND POWER FEEDRAILS PER OMI Q6003. OPERATIONAL TEST PERFORMED PRIOR TO OPERATIONS PER OMI Q3008.
	G8 MOTION CON- TINUES IN VERTICAL/HORI- ZONTAL DIREC- TION		DEVELOPED UNDER HAZARDOUS CONDITION G8.	DEVELOPED UNDER HAZARDOUS CONDITION G8.
	OR G7 IMPROPER LOAD POSI- TIONING		DEVELOPED UNDER HAZARDOUS CONDITION G7.	DEVELOPED UNDER HAZARDOUS CONDITION G7.
	OR G9 INADVERTENT MOVEMENT OF LOAD		DEVELOPED UNDER HAZARDOUS CONDITION G9.	DEVELOPED UNDER HAZARDOUS CONDITION G9.
	OR G10 SPEED INCREASE FASTER THAN COMMANDED		DEVELOPED UNDER HAZARDOUS CONDITION G10.	DEVELOPED UNDER HAZARDOUS CONDITION G10.

Table 64 (Page 9 of 11). **HAZARD ANALYSIS WORKSHEETS**

Phase/Mode Function 175-TON BRIDGE CRANE			Date JULY 1993	
Task/Operation or Facility VAB			Prepared by J. GARRETT, LSOC 52-11	
HAZARDOUS CONDITION	HAZARD CAUSE	HAZARD EFFECT	SAFETY/ENGINEERING REQUIREMENTS	HAZARD ELIMINATION/CONTROL PROVISIONS
G8 MOTION CONTINUES IN VERTICAL/HORIZONTAL DIRECTION	G14 MOTION FAILS TO STOP WHEN COMMANDED OR E14 OPERATOR/OBSERVER ERROR	G3 LOAD COLLIDES WITH OBJECT	DEVELOPED UNDER HAZARDOUS CONDITION G14. E14 NSS/GO 1740.9B, 205a, ONLY CERTIFIED AND TRAINED OPERATORS SHALL USE/ OPERATE CRANES.	DEVELOPED UNDER HAZARDOUS CONDITION G14. E14 CRITICAL SKILLS VERIFIED FOR CRANE OPERATORS AND OBSERVERS (CSR 019-1, 091-1, 094-1, 019-4, 091-4 AND 094-4) PRIOR TO OPERATIONS PER OMI Q3008. SUPPLEMENTARY OPERATOR INSTRUCTIONS GIVEN IN OMI Q3008, APPENDIX C. EMERGENCY INSTRUCTIONS GIVEN PER OMI Q3008, APPENDIX Z. COMMUNICATIONS CHECK PRIOR TO OPERATIONS PER OMI Q3008.
G9 INADVERTENT MOVEMENT OF LOAD	G15 LOSS OF EMERGENCY-STOPPING CAPABILITY AND E15 FAILURE OF ONE OR MORE ELECTRICAL COMPONENTS	G3 LOAD COLLIDES WITH OBJECT	DEVELOPED UNDER HAZARDOUS CONDITION G15. E15 NSS/GO 1740.9B, 201g.(6), ELECTRICAL SYSTEMS SHALL BE DESIGNED FAILSAFE; 202c, OPERATIONAL TESTS REQUIRED; 203, PERIODIC INSPECTION REQUIRED; 204, PERIODIC MAINTENANCE REQUIRED. OMRSD FILE VI GTAFCRVD0.026 REQUIRES OPERATIONAL TEST. OMRSD FILE VI GTAFCRVD0.027 REQUIRES AMMETER S/O POINT.	DEVELOPED UNDER HAZARDOUS CONDITION G15. E15 PERIODIC MAINTENANCE AND INSPECTION PERFORMED INCLUDING MONTHLY OPERATIONAL TEST; SEMIANNUAL INSPECTION OF ELECTRICAL ROTATING MACHINERY, COMMUTATORS AND INSULATION RESISTANCE CHECK; AND ANNUAL INSPECTION OF CONTACTS AND CONTACT MEMBERS, ELECTRICAL WIRING, RESISTORS, SELSYNS AND POWER FEEDRAILS PER OMI Q6003. OPERATIONAL TEST PERFORMED PRIOR TO OPERATIONS PER OMI Q3008.

Table 64 (Page 10 of 11). HAZARD ANALYSIS WORKSHEETS				
Phase/Mode Function 175-TON BRIDGE CRANE			Date JULY 1993	
Task/Operation or Facility VAB			Prepared by J. GARRETT, LSOC 52-11	
HAZARDOUS CONDITION	HAZARD CAUSE	HAZARD EFFECT	SAFETY/ENGINEERING REQUIREMENTS	HAZARD ELIMINATION/CONTROL PROVISIONS
G10 SPEED INCREASE FASTER THAN COMMANDED	G15 LOSS OF EMERGENCY- STOPPING CAPABILITY AND E15 FAILURE OF ONE OR MORE ELECTRICAL COMPONENTS	G3 LOAD COLLIDES WITH OBJECT	DEVELOPED UNDER HAZARDOUS CONDITION G15. E15 NSS/GO 1740.9B, 201g.(6). ELECTRICAL SYSTEMS SHALL BE DESIGNED FAILSAFE; 202c, OPERATIONAL TESTS REQUIRED; 203, PERIODIC INSPECTION REQUIRED; 204, PERIODIC MAINTENANCE REQUIRED. OMRSD FILE VI GTAFRCRVD0.026 REQUIRES OPERATIONAL TEST. OMRSD FILE VI GTAFRCRVD0.027 REQUIRES AMMETER S/O POINT.	DEVELOPED UNDER HAZARDOUS CONDITION G15. E15 PERIODIC MAINTENANCE AND INSPECTION PERFORMED INCLUDING MONTHLY OPERATIONAL TEST; SEMIANNUAL INSPECTION OF ELECTRICAL ROTATING MACHINERY, COMMUTATORS AND INSULATION RESISTANCE CHECK; AND ANNUAL INSPECTION OF CONTACTS AND CONTACT MEMBERS ELECTRICAL WIRING, RESISTORS, SELSYNS AND POWER FEEDRAILS PER OMI Q6003. OPERATIONAL TEST PERFORMED PRIOR TO OPERATIONS PER OMI Q3008.
G15 LOSS OF EMERGENCY- STOPPING CAPABILITY	E14 OPERATOR/ OBSERVER ERROR	G15 MOTION FAILS TO STOP WHEN COMMANDED AND G9 INADVERTENT MOVEMENT OF LOAD AND G10 SPEED INCREASE FASTER THAN COMMANDED	E14 NSS/GO 1740.9B, 205a, ONLY CERTIFIED AND TRAINED OPERATORS SHALL USE/ OPERATE CRANES.	E14 CRITICAL SKILLS VERIFIED FOR CRANE OPERATORS AND OBSERVERS (CSR 019-1, 091-1, 094-1, 019-4, 091-4 AND 094-4) PRIOR TO OPERATIONS PER OMI Q3008. SUPPLEMENTARY OPERATOR INSTRUCTIONS GIVEN IN OMI Q3008, APPENDIX C. EMERGENCY INSTRUCTIONS GIVEN PER OMI Q3008, APPENDIX Z. COMMUNICATIONS CHECK PRIOR TO OPERATIONS PER OMI Q3008.

Table 64 (Page 11 of 11). HAZARD ANALYSIS WORKSHEETS				
Phase/Mode Function 175-TON BRIDGE CRANE			Date JULY 1993	
Task/Operation or Facility VAB			Prepared by J. GARRETT, LSOC 52-11	
HAZARDOUS CONDITION	HAZARD CAUSE	HAZARD EFFECT	SAFETY/ENGINEERING REQUIREMENTS	HAZARD ELIMINATION/CONTROL PROVISIONS
	<p>OR</p> <p>E20 EMERGENCY-STOP CONTROL FAILURE</p> <p>OR</p> <p>E21 INSUFFICIENT REACTION TIME</p>		<p>E20 NSS/G0 1740.9B, 201g.(4), A RED, EMERGENCY STOP PUSH-BUTTON SHALL BE PROVIDED; 201g.(8), REMOTE EMERGENCY-STOP ARE REQUIRED FOR CRITICAL LIFTS WHERE OPERATOR'S VIEW IS RESTRICTED; 202c, OPERATIONAL TEST REQUIRED; 203, PERIODIC INSPECTION REQUIRED; 204, PERIODIC MAINTENANCE REQUIRED.</p> <p>OMRSD FILE VI GTAFCRVD0.026 REQUIRES OPERATIONAL TEST.</p> <p>E21 NSS/G0 1740.9B, 205a, ONLY CERTIFIED AND TRAINED OPERATORS SHALL USE/OPERATE CRANES.</p>	<p>E20 PERIODIC MAINTENANCE AND INSPECTION INCLUDES MONTHLY VERIFICATION OF EMERGENCY-STOP CONTROL ASSEMBLY CERTIFICATION AND OPERATIONAL TEST PER OMI Q6003.</p> <p>OPERATIONAL TEST PERFORMED PRIOR TO LIFT PER OMI Q3008.</p> <p>REMOTE EMERGENCY-STOP ARE PROVIDED.</p> <p>E21 CRITICAL SKILLS VERIFIED FOR CRANE OPERATORS AND OBSERVERS (CSR 019-1, 091-1, 094-1, 019-4, 091-4 AND 094-4) PRIOR TO OPERATIONS PER OMI Q3008.</p> <p>SUPPLEMENTARY OPERATOR INSTRUCTIONS GIVEN IN OMI Q3008, APPENDIX C.</p> <p>EMERGENCY INSTRUCTIONS GIVEN PER OMI Q3008, APPENDIX Z.</p> <p>COMMUNICATIONS CHECK PRIOR TO OPERATIONS PER OMI Q3008.</p>

8.0 LPS CONTROL/MONITOR FUNCTIONS REVIEW

8.1 APPLICATION SET CONTROL LOGIC REVIEW

8.1.1 Prerequisite Control Logic Review. There is no Prerequisite Control Logic associated with the critical functions assessed in section 4.0 for this system; therefore, no Prerequisite Control Logic Review is required.

8.1.2 Reactive Control Logic Review. There is no Reactive Control Logic associated with the critical functions assessed in section 4.0 for this system; therefore, no Reactive Control Logic Review is required.

8.2 LAUNCH COMMIT CRITERIA AND GROUND LAUNCH SEQUENCER REVIEW

There are no Launch Commit Criteria requirements for this system; therefore, no Launch Commit Criteria and Ground Launch Sequencer Review is required.

8.3 FUNCTION DESIGNATOR ANALYSIS

The LPS/CCMS does not provide any control/monitor functions for the critical functions assessed in section 4.0 for this system; therefore, no LPS/CCMS Control Function Analysis is required.

9.0 END-TO-END ANALYSIS

This system interfaces with and requires the support of the systems depicted in Figure 26, End-to-End Block Diagram. An assessment of the loss of each interfacing system follows.

Table 65. **INTERFACING SYSTEM LOSS ASSESSMENT**

<u>Interfacing System Title</u>	<u>Effect of Loss</u>	<u>SAA Number</u>	<u>Concurrence in Other SAA Comments</u>
VAB 60 Hz Facility Power	Delay of oper- ations	09ELR2-001	Yes
RF Communi- cations System at the VAB Cranes	Possible damage to a vehicle system	09CU07-009	Yes
ET Forward and Aft Erection Slings at the VAB	Possible damage to a vehicle system	09FT07-006	Yes
Orbiter Mating Sling Set	Possible loss of life and/or vehicle	SAR H70-0597	N/A

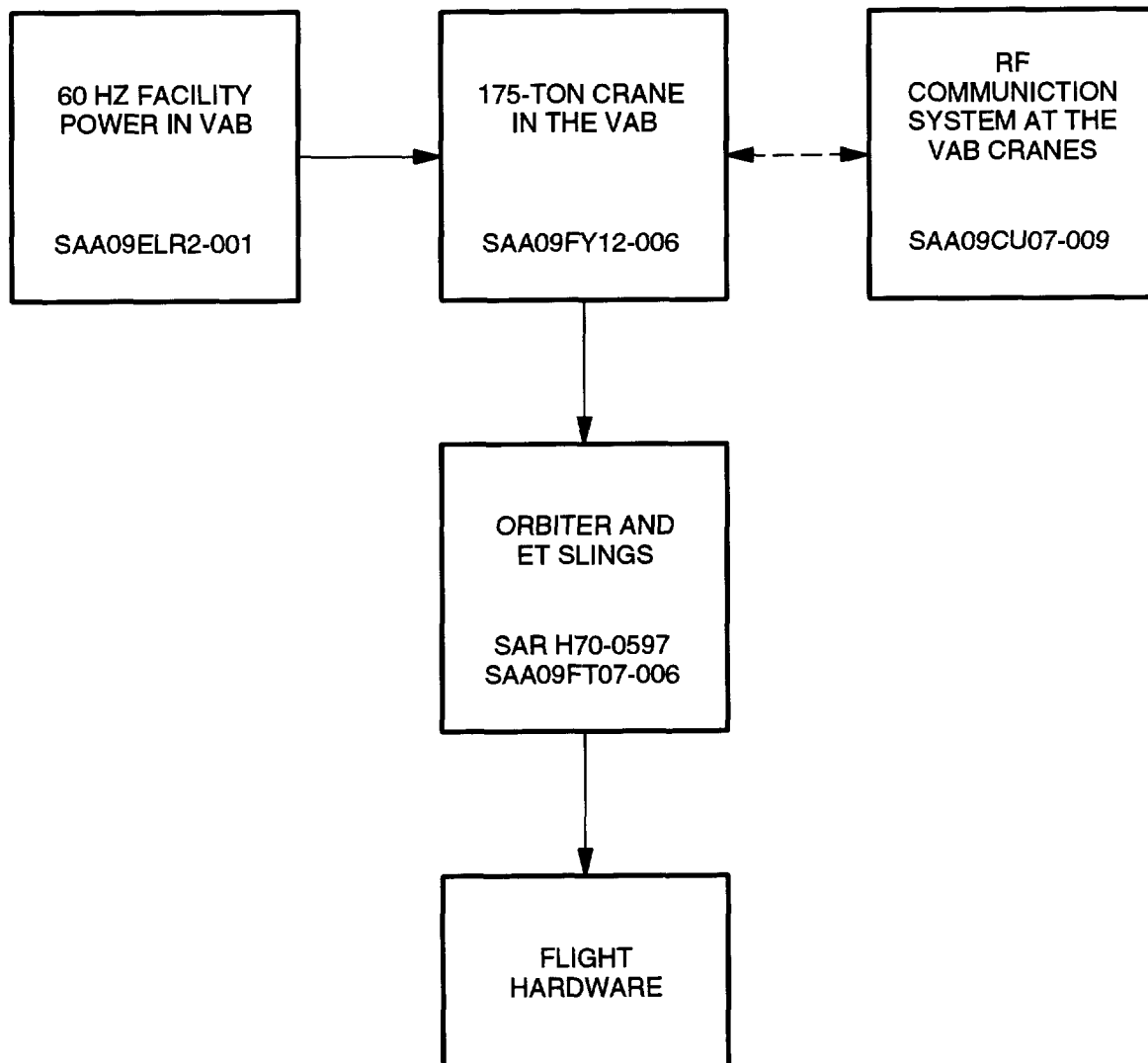


FIGURE 25. END-TO-END SYSTEM BLOCK DIAGRAM FOR VAB 175-TON CRANE

10.0 SNEAK CIRCUIT ANALYSIS

There was no Sneak Circuit Analysis performed on this system.

11.0 EMERGENCY SAFING ANALYSIS

There are no Emergency Safing Circuits associated with this system.

12.0 AREAS OF CONCERN

There were no Areas of Concern identified during this analysis.

13.0 CRITICALITY CATEGORY 1R ANALYSIS

Improper performance of this system could result in loss of life or vehicle; therefore, the components used in the critical functions are analyzed in the following reliability block diagram.

13.1 RELIABILITY BLOCK DIAGRAM

The components of this system are described in the following reliability block diagram. The reliability block diagram depicts the logical relationship of system components in series and parallel paths that lead to the desired event. Those items identified as criticality category 1R are summarized in section 13.2.

Module : 175TMH
 Description : MAIN HOIST
 MECHANICAL DRIVE

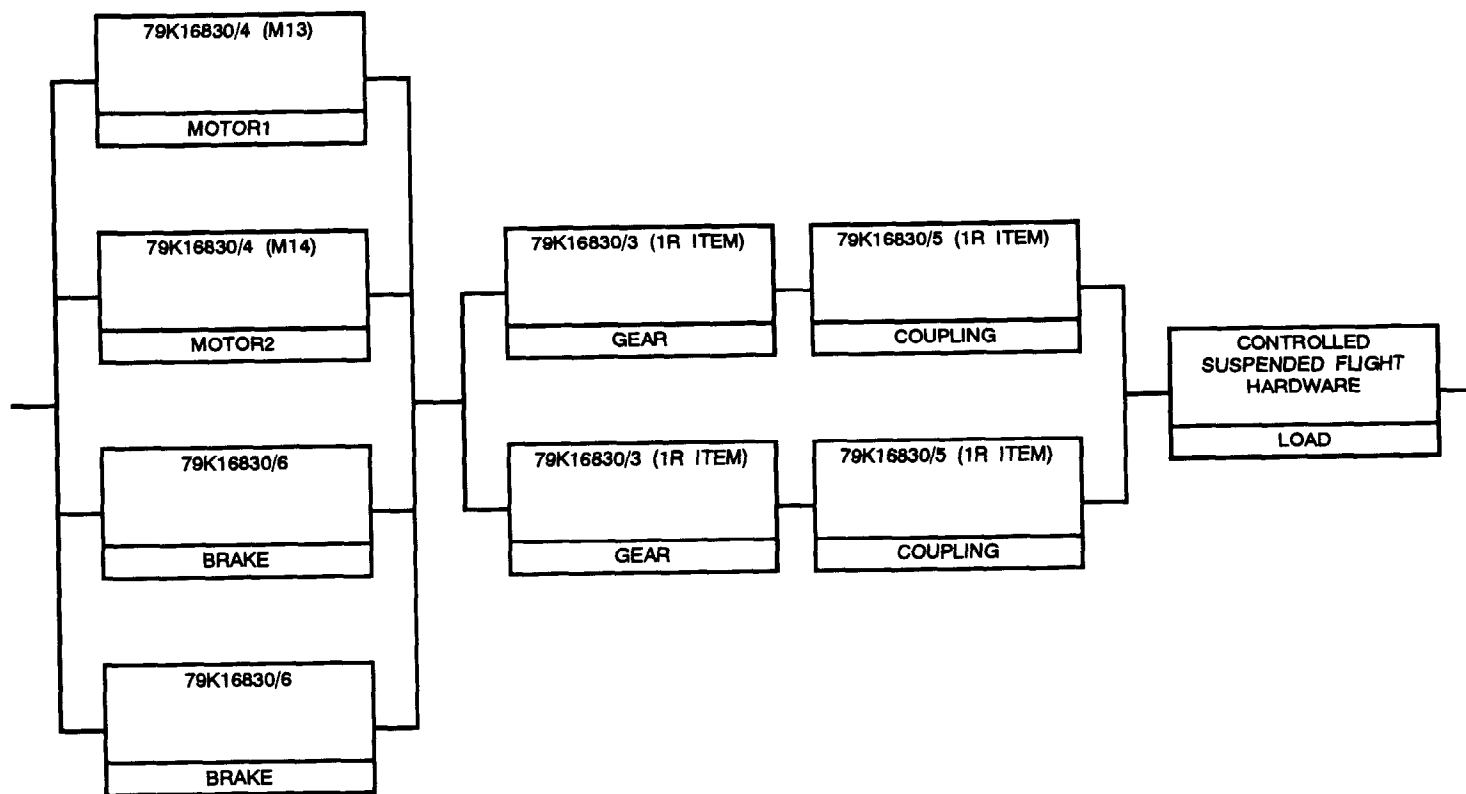


FIGURE 26. RELIABILITY BLOCK DIAGRAM OF THE MAIN HOIST MECHANICAL DRIVE.

SAO9FY12-006
 REV. B

13.2 CRITICALITY CATEGORY 1R ITEMS

There were 4 criticality category 1R items identified. See section 13.1 for additional information. The 1R items are summarized on the following Criticality Category 1R Items Summary Sheets (Worksheet 5312-015).

Table 66. **CRITICALITY CATEGORY 1R ITEMS SUMMARY**

System 175-TON BRIDGE CRANE, VAB Baseline 389.00		Program SPACE SHUTTLE				Station Set/Facility Code TA Date JULY 1993 Prepared By C. CRABB, LSOC 52-11		
FIND NO. NASA PART NO. MFG NAME MFG PART NO.	PART NAME PROGRAM MODEL NO. DRAWING/SHEET NO.	a. FAILURE MODE b. CAUSE c. FMN	FAILURE EFFECT ON SYSTEM PERFORMANCE/VEHICLE SYSTEMS AND/OR PERSONNEL SAFETY	REDUNDANCY SCREENS PASS - FAIL		CONFORMS TO JSCM 8080	OMRS FILE VI VOLUME I TEST AND INSPECTION REQUIREMENT(S)	TEAR DOWN ANALYSIS REQUIRED
79K16830/3 / NONE/ WESTERN GEAR/ D605	GEAR TRAIN, MAIN HOIST/ K60-0528 79K16830/2	a. GEAR DISENGAGE- MENT b. STRUCTURAL FAILURE c. 09FY12-006.091	LOSS OF ABILITY TO HOLD THE LOAD IF COUPLED WITH A FAILURE IN THE REDUNDANT DRIVE SYSTEM. POSSIBLE LOSS OF LIFE AND/OR VEHICLE.	A B C	- - -	N/A	OMRSD FILE VI REQUIRES VERIFICATION OF PROPER PERFORMANCE OF HOIST OPERATIONAL TEST ANNU- ALLY.	NO
79K16830/3 / NONE/ WESTERN GEAR/ D605	GEAR TRAIN, MAIN HOIST/ K60-0528 79K16830/2	a. GEAR DISENGAGE- MENT b. STRUCTURAL FAILURE c. 09FY12-006.092	LOSS OF ABILITY TO HOLD THE LOAD IF COUPLED WITH A FAILURE IN THE REDUNDANT DRIVE SYSTEM. POSSIBLE LOSS OF LIFE AND/OR VEHICLE.	A B C	- - -	N/A	OMRSD FILE VI REQUIRES VERIFICATION OF PROPER PERFORMANCE OF HOIST OPERATIONAL TEST ANNU- ALLY.	NO
79K16830/5 / NONE/ SIER-BATH/ SIZE 3-1/2	FLEX COUPLING, MAIN HOIST/ K60-0528 79K16830/2	a. DISENGAGES b. STRUCTURAL FAILURE c. 09FY12-006.093	LOSS OF ABILITY TO HOLD THE LOAD IF COUPLED WITH A FAILURE IN THE REDUNDANT DRIVE SYSTEM. POSSIBLE LOSS OF LIFE AND/OR VEHICLE.	A B C	- - -	N/A	OMRSD FILE VI REQUIRES VERIFICATION OF PROPER PERFORMANCE OF HOIST OPERATIONAL TEST ANNU- ALLY.	NO
79K16830/5 / NONE/ SIER-BATH/ SIZE 3-1/2	FLEX COUPLING, MAIN HOIST/ K60-0528 79K16830/2	a. DISENGAGES b. STRUCTURAL FAILURE c. 09FY12-006.094	LOSS OF ABILITY TO HOLD THE LOAD IF COUPLED WITH A FAILURE IN THE REDUNDANT DRIVE SYSTEM. POSSIBLE LOSS OF LIFE AND/OR VEHICLE.	A B C	- - -	N/A	OMRSD FILE VI REQUIRES VERIFICATION OF PROPER PERFORMANCE OF HOIST OPERATIONAL TEST ANNU- ALLY.	NO